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VOLUME XXVI NUMBER 4

BOTANICAL GAZETTE

OCTOBER 1898

KARYOKINESIS IN THE ROOT TIPS OF ALLIUM CEPA.[1]

JOHN H. SCHAFFNER.

(WITH PLATES XXI AND XXII)

FOR several years the writer has desired to study in detail the formation of the achromatic spindle in the root tips of *Allium Cepa*, having frequently seen interesting figures in the early stages of division while investigating the subject of centrospheres in this plant. Especially was the desire increased when the interesting series of papers appeared from the Bonn Botanical Institute[2] dealing especially with the origin of the nuclear spindle. Accordingly a set of preparations was made, the material being killed in several fixing fluids, and stained in various ways, so that any irregularity due to technique might be eliminated. Flemming's weaker and stronger fluid and chrom-acetic acid seemed to give the best results, although several others worked fairly well. So far as the appearance of the spindle was concerned there did not seem to be any great difference in the effect produced by the several fluids. Chrom-acetic acid is without doubt the best for general purposes, as it preserves the structures of the dividing nucleus just as faithfully as Flemming's, and does not interfere with the action of the stains used.

[1] Contributions from the botanical laboratory of Ohio State University. III.

[2] Jahrbücher für wiss. Bot. **30**: 159–422. 1897.

The proportions were as follows: Chromic acid, 0.8cc; acetic acid, 0.5cc; water, 99.0cc. The combinations of stains giving the best results were anilin-safranin and gentian-violet; iron-alum-haematoxylin; and anilin-safranin and iron-alum-haematoxylin.

ANILIN-SAFRANIN, GENTIAN-VIOLET.

1. Anilin-safranin alcoholic (50 per cent.) solution prepared by combining equal parts of anilin water, and saturated alcoholic (95 per cent.) solution of safranin.

2. Gentian-violet 2 per cent. aqueous solution. Stain from two to four hours in the safranin, and from two to four minutes in the gentian-violet. The slides must be taken through the alcohols quite rapidly or the stain will be lost.

HEIDENHAIN'S IRON-ALUM-HAEMATOXYLIN.

1. Ammonio-sulphate of iron 2 per cent. aqueous solution.

2. Haematoxylin, a ½ per cent. solution obtained by dissolving in hot water.

Keep the sections from two to four hours in the iron-alum, and then from eight to twelve hours in the haematoxylin, afterwards taking out the excess of stain with the iron-alum until the sections are of the proper color.

ANILIN-SAFRANIN, IRON-ALUM-HAEMATOXYLIN.

This was by far the best combination used, bringing out with remarkable distinctness chromatin network, chromosomes, nucleoli, spindles and centrospheres. The centrosomes were especially distinct in some pollen mother cells of *Sagittaria variabilis*, showing as large, black, spherical granules at the poles of the spindle. The sections are stained in the usual way in the anilin-safranin for two or three hours, and then carried through the iron-alum-haematoxylin in the same manner as when this combination is used alone. This method, although tedious, will amply repay in results for the long time necessary for the staining. The combination is improved a little, perhaps, by staining for two minutes after the anilin-safranin in gentian-violet.

The material was imbedded in paraffin, sectioned from 10–18 μ thick and stained on the slide.

The root tips of *Allium Cepa* L. are very favorable objects for the study of karyokinesis, and in making a critical investigation of the structures and activities of the cell during division

it was thought best to take some such common object, which could be followed easily in the class room, and tested as to its accuracy. Accounts and figures of karyokinesis in plant cells are very scarce, and the so-called diagrammatic or schematic figures and descriptions given in most of the text-books are but a poor guide for the student and young investigator. For these reasons a rather complete account of the whole process has been given.

The most typical resting nuclei occur some distance back of the tip beyond the actively dividing region. Here, in good stained material, the nuclei usually have one or two large nucleoli and a very distinct chromatin network, with large irregular chromatin granules, which usually appear at the crossings of the meshes (*fig. 1*). In these cells there are large vacuoles, and it is rarely that the cytoplasmic contents or the centrospheres show to advantage. However, if one goes near the tip, in the actively dividing region, it is easy to find cells showing all the various cell organs usually present. The cells mostly divide in but one plane by transverse walls, and at the upper or lower side of the nucleus there is usually a depression in which two small bodies lie (*fig. 2*). The presence of this depression, and two characteristic bodies in it leave but little doubt as to their nature. They are to all intents and purposes centrospheres. Just at the time when the nucleus begins to divide it generally stains much deeper, and around it may be seen radiating streams of cytoplasm (*fig. 3*). While the nucleus is in this condition the finer chromatin threads disappear. Just how this disappearance takes place it is not easy to tell. The finer meshes seem to be drawn into the coarser threads, or if this is not the case the whole thread shortens and thickens, thus becoming more evident, and also giving the appearance that there are fewer threads present. While this process is going on the centrospheres separate and take up their positions on opposite sides of the nucleus, being closely applied to the nuclear membrane (*fig. 4*). As the chromatin thread continues to shorten and thicken the incept[3] of the

[3] The word *incept* is used as the equivalent of the German *Anlage*.

achromatic spindle makes its appearance. This arises as two flattened, dome-shaped prominences on opposite sides of the nucleus. These seem to inclose the nucleus completely, and at their summits can usually be seen two spherical bodies, the centrospheres, each with a dark center, the centrosome, around which there is a series of cytoplasmic radiations (*figs. 5, 8, 11*). Sometimes there is an outer granular zone near the limit of the radiations (*figs. 8, 24*). Thus it seems that the spindle originates from the two opposite centrospheres. The spindle usually arises on the two flattened sides of the nucleus (*figs. 5, 10, 12*), but sometimes it originates on the ends of the long axis of the nucleus. It is nearly always very much rounded and flattened at first, except in cases of long narrow cells, in which it seems to be pointed from the very first. In the younger stages the radiations are often not very marked, in other cases they are very distinct and very thick but few in number. In case the spindle is formed on the ends of the long axis of the nucleus it cannot be seen as early as usual, since it then lies very close to the nucleus (*fig. 7*). Although the centrospheres generally separate quite early and take their position on opposite sides of the nucleus, they may sometimes be considerably delayed. *Fig. 9* seems to be such a case, where the chromatin band is well formed but the two centrospheres are still close together and their centrosomes have begun to divide. This figure may be explained by supposing a late separation of the centrospheres and a precocious division of the centrosomes. There are beautiful, delicate radiations passing out into the cytoplasm. In some cells the incept of the spindle remains dome-shaped and very much flattened for a long time, and frequently no bodies can be seen which look like centrosomes. It need not be implied, however, that centrosomes are not present in such cases. In cells of about the same age the spindles are often becoming pointed and show a centrosphere in close contact with the spindle fibers, and having well developed radiations around the poles (*figs. 11, 13*). In *fig. 10* there is a system of streams of cytoplasm passing out from the young spindle to the cell wall. These are no doubt ordinary

delicate streams of cytoplasm and are of the same nature as those shown in *fig. 3*. They have nothing to do directly with the formation of the spindle. The incept of the spindle is very sharply differentiated from the surrounding cytoplasm and the space between it and the nuclear membrane appears very clear and transparent, like the achromatin of the nucleus.

After the chromatin band has become considerably thickened it loops up into sixteen definite loops, the heads of which, in typical cases, point toward the two poles (*figs. 13, 14*). The loops, however, do not always seem to have this position in relation to the poles, as is shown by *figs. 15* and *16*. When one looks down from one pole nothing is seen of the nuclear spindle (*fig. 14*). The dome-shaped spindle gradually extends outward and becomes pointed, until the time of the breaking of the chromatin coil into a definite number of chromosomes, accompanied by the disappearance of the nuclear membrane (*figs. 15–20*). In these stages the centrospheres become more prominent, probably through expansion or growth previous to division. The fate of the nucleoli was not discovered. They have generally disappeared by the time the chromatin coil has segmented. In some cases they appear quite vacuolate (*fig. 11*), in others of the same consistency throughout (*figs. 15, 16*). It will be seen from an examination of the figures that the spindle is bipolar from the first. It arises as two closely applied caps on opposite sides of the nucleus at the summits of which are well defined centrospheres. These centrospheres gradually extend outwards, drawing the spindle into a sharp pointed bipolar structure. In the case of the onion, therefore, it is an impossibility for the spindle to arise by an aggregation of many cytoplasmic radiations which first form multipolar structures passing out on all sides of the nucleus, as has been described by Mottier, Osterhout, and others. The spindle is so sharply defined from the very first that it can be traced step by step in all its stages of development, its limits always appearing with proper staining very distinct and sharply differentiated from the cytoplasm. In some cases, where the cells are very flat in

longitudinal diameter, the spindle also appears very much flattened (*fig. 21*). Were such a spindle sectioned it could easily give the appearance of a multipolar structure. No such cases, however, were found. If the spindle extended clear across the cell so that it touched the opposite walls it might give the appearance of the threads ending in the cell wall. Although the nature and origin of the spindles in *figs. 19*, *21* and *22* are exactly the same, there is a striking difference in their shape, and very suggestive of how the shape of the cell may influence the appearance of the karyokinetic figures. The same is evident from a comparison of *figs. 6* and *10*. Often the two poles of a spindle are not 180° apart. This is caused no doubt by the centrospheres not becoming exactly opposed (*fig. 19*). After the nuclear membrane has disappeared the V-shaped chromosomes are gradually drawn down into the equatorial plane, with their heads toward the center, until they form quite a symmetrical figure (*figs. 22–26*). The centrosome usually does not divide until after the formation of the mother star, but sometimes the division may occur earlier (*fig. 23*). The longitudinal splitting of the chromosomes takes place about or during the time of the formation of the mother star (*figs. 27*, *28*). When the cell is very long and narrow there does not appear to be a typical mother star formed (*fig. 24*). In such cases the chromosomes do not appear to be drawn symmetrically into the equatorial plane. The chromosomes appeared quite homogeneous throughout, nothing being visible having the appearance of chromatin granules. It was not possible to tell exactly how the chromosomes are arranged on the achromatic spindle threads, but the threads seemed to be in bundles running continuously from one pole to another, ending in the hyaline area of the centrosphere and having the chromosomes attached by their heads (*figs. 28–30*).

When the chromosomes have been brought into the equatorial plane, and longitudinal splitting is complete, the daughter chromosomes are gradually pulled apart, and the central spindle begins to appear between them in the equatorial region. Some-

times the figures of the metakinesis stage are remarkable for their symmetrical development (*figs. 29, 30*). Such symmetry could not be present were the two ends of the spindle formed at haphazard from variable numbers of irregular smaller elements. The centrosomes usually divide during metakinesis (*figs. 31, 32*). By the time the daughter chromosomes have arranged themselves around the poles, the centrospheres, as a general rule, have divided and the radiations show more prominently than in the earlier stages (*fig. 23*). The chromosomes now begin to contract and the free ends turn inwards, while at the same time the threads of the central spindle become thickened and stain much deeper than before. The polar radiations also become more widely separated because of the outward pressure exerted by the chromosomes (*fig. 34*). At the time when the chromosomes are curving inward the central spindle threads begin to bulge outwards, and the cell plate is formed from the center, appearing at first as granular thickenings in the spindle threads. In this stage the centrospheres often appear still united but containing a double centrosome (*figs. 35, 36*). In *fig. 37* only one centrosphere is visible at the upper pole, the other one lying immediately beneath the one in view.

The central spindle continues to bulge outward and the cell plate becomes larger, until finally when it reaches the cell walls the spindle has a very flattened appearance (*figs. 38, 39*). The spindle threads continue to stain very dark at the center until the cell plate is complete. What the cause of this dark staining may be was not discovered. It was probably due to the presence of various materials in the thickened spindle threads which are used in the formation of the cell wall. It is not easy to understand how the threads of the central spindle extend outward until they are sometimes almost doubled on themselves. But whatever the direct cause, they are considerably longer than they were at first. The central spindle threads disappear as soon as the cell wall is well formed, being absent in the center while they are still prominent in the outer regions (*fig. 39*). As soon as the cell wall is complete the threads disappear

entirely. Whether they remain in the cytoplasm, or are withdrawn into the nucleus, or furnish part of the material for the nuclear membrane, are all matters of mere conjecture. The nucleoli begin to appear a little before the time when the cell wall has been completely formed.

Fig. 41 is an interesting case in that it shows the centrosome not yet divided in a very late stage. This body appears as a long, black, rod-like body forming a slender dumb-bell. The chromatin bands seem to be distributed again or spread out in a fine network, and the nucleus continues to swell out and become more rounded until the complete resting stage is again attained. The depression formed at the pole, however, remains, and in this there can often be seen exceedingly distinct centrospheres. Although the cases in the resting condition are not numerous where these bodies appear very distinct, yet in such cases as *fig. 42* there can be no doubt of the continuance of the centrospheres into the resting stage of the nucleus. In the example given in *fig. 42* the whole cell is remarkably clear and free from granules, the two prominent bodies lying alone in the polar depression. To claim that these bodies are not centrospheres would be exceedingly dogmatic, and the only recourse left would be to name and describe two new organs of the cell which have the same appearance and occupy the same position as do real centrospheres.

The general process of karyokinesis for the onion root may be summarized as follows:

I. PROPHASE.

1. The division begins with the separation of the centrospheres, and when these have moved apart nearly 180° the incept of the achromatic spindle appears, forming two dome-shaped projections on opposite sides of the nucleus, at the summits of which the centrospheres are situated, forming the poles around which are cytoplasmic radiations. At the same time the chromatin network is transformed into a continuous ribbon or spirem producing the figure known as the *close mother skein* (*figs. 2–10*).

2. The continuous spirem shortens and thickens and is looped into a definite number of loops, the heads of which, in typical cases, point toward the two poles of the spindle. The nucleoli and nuclear membrane disappear and the dome-shaped spindle becomes more pointed by the outward extension of the poles. This stage ends with the breaking of the chromatin loops into separate chromosomes, and it may appropriately be called the *looped mother skein* (*figs. 11–19*).

II. METAPHASE.

3. After the nuclear membrane disappears, the separate chromosomes are drawn down, with their heads toward the center, into the equatorial plane, while the spindle continues to become more pointed (*figs. 20–25*). This constitutes the *loose mother skein* stage.

4. When the chromosomes have come into the equatorial plane, there is a pause resulting from the seeming pull of the spindle fibers in opposite directions, which holds the chromosomes rigidly until the longitudinal splitting of the chromosomes is complete, when separation of the daughter chromosomes begins (*figs. 26–28*). This constitutes the *mother star* stage.

III. ANAPHASE.

5. After the longitudinal segmentation of the chromosomes which, as a general rule, does not begin until the chromosomes are in the equatorial plane, the daughter chromosomes are gradually pulled apart, the separation beginning at the heads of the loops. The centrosomes usually divide during this stage, though in some cases the division may be considerably earlier. This stage is appropriately known as *metakinesis* (*figs. 29–31*).

6. The daughter chromosomes having been completely pulled apart, now travel to the poles and arrange themselves in star-shaped figures around the poles, while the central spindle appears between the two stars. The radiations around the centrospheres, which now contain two separate centrosomes, become more prominent (*figs. 32, 33*). This is the *daughter star* stage.

IV. TELOPHASE.

7. The chromosomes having oriented themselves around the poles, now begin to contract, becoming wavy in outline, and the free ends curve inward. The threads of the central spindle begin to thicken preparatory to the formation of the cell plate. In the center of each thickened thread a granule appears, these being formed first in the central strands, and as the spindle bulges outward the cell plate gradually enlarges until it reaches the surrounding cell wall. In the meantime the nucleoli begin to appear in the daughter nuclei. This stage may be called the *loose daughter skein*, and may be considered to end when the cell plate is complete (*figs. 34–39*).

8. After the daughter cells are completely separated by the new cell wall the threads of the central spindle disappear, and the daughter nuclei appear with complete nuclear membranes. The chromosomes begin to be transformed again into the chromatin network; the radiations disappear from around the centrospheres, which have now usually divided completely into two separate bodies; and the two daughter nuclei in the meantime expand and take on a more spherical form until they enter again into the resting stage (*figs. 40–42*). This stage may be known as the *close daughter skein*.

Fig. 1 may be taken as a typical nucleus in the tissue beyond the growing point, showing in detail the actual arrangement of the chromatin network, chromatin granules, and nucleolus. *Fig. 2* represents a typical cell in the active part of the meristematic region.

To illustrate the normal order of karyokinesis, the following figures may be taken as a complete series: *2, 4, 5, 8, 11, 13, 16, 17; 20, 22, 25; 26, 27, 29, 30, 32, 33; 34, 35, 36, 38; 39, 40, 42.* A briefer series may be represented by the following: *2, 5, 8, 13, 17, 20, 25, 26, 27, 30, 32, 33, 34, 36, 39, 40, 42.*

SAGITTARIA VARIABILIS.

The anilin-safranin, iron-alum-haematoxylin combination was also tried on dividing pollen mother cells of Sagittaria. The results were even more striking than in the onion. In the mother star stage the centrosomes at the poles look like large black

spherical granules, but the attraction sphere is usually not very well differentiated. The poles usually lie very close to the wall of the cell, giving little or no room for polar radiations (*figs. 43, 44*). The figures drawn are not exceptional cases, but scores of similar figures can be seen in a single section across the flower bud. From a careful estimate, I have a single slide which will show several hundred figures of the same nature as those given. A careful search was again made for multipolar spindles, and in this material they are frequently seen. This is not at all surprising, however, and is exactly what must necessarily follow the sectioning of tissues where the spindles do not all lie in the same plane. Especially in thin sections is the pole often cut away, giving the appearance that the spindle does not end in a single point. Since the spindle threads in Sagittaria pollen mother cells are massed into definite bundles, any injury to the spindle will produce a multipolar spindle. Such a case is shown in *fig. 45*, where the cell has been crushed at one end, producing four apparently separate spindles on the lower side, while the upper end is practically intact. The centrospheres appear at the two original poles. At the present time, in all the material examined by the writer, multipolar spindles seem due entirely to two causes: first, to pathological conditions; and second, to injuries of the spindle produced by improper manipulation in preparing the sections. The latter may be due to a variety of causes. Among the more common of these may be mentioned improper killing and treatment of material, sectioning the cells into such thin slices that the poles are entirely lost or injured, cutting off the poles from the spindles which lie diagonally to the plane of the section, and finally, injury by crushing the cells in such a manner that the spindle is spread out and torn.

COLUMBUS, O.

EXPLANATION OF PLATES XXI, XXII.

The drawings have been reduced three-eighths of their original size. They were drawn with an Abbé camera, and except in one instance combinations of Zeiss and Bausch and Lomb oculars and objectives were used.

PLATE XXI.

FIG. 1. A resting nucleus from a cell beyond the growing point. Anilin-safranin, iron-alum-haematoxylin. Zeiss oc. 18, B. and L. obj. $\frac{1}{12}$.

FIG. 2. Resting cell with centrospheres from the growing point. Anilin-safranin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 3. Cell just before division, stained very deeply. Iron-alum-haematoxylin. Zeiss. oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 4. Nucleus with centrospheres on opposite sides, in early stage of division. Iron-alum-haematoxylin. Zeiss oc. 12, obj. 2^{mm} ap. hom. im.

FIG. 5. Cell with incept of achromatic spindle and centrospheres at the poles. Iron-alum-haematoxylin. Zeiss. oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 6. Long cell with bipolar spindle having sharper ends than usual at this stage. Acid fuchsin, methyl-green. Zeiss. oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 7. Close mother skein with no spindle visible, but with radiations at the two ends of the nucleus. Anilin-safranin, iron-alum-haematoxylin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 8. Cell with centrospheres and granular zones outside of the polar radiations. Iron-alum-haematoxylin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 9. Cell with late separation of centrospheres and precocious division of the centrosomes. Delicate radiations around the centrospheres. Anilin-safranin, gentian-violet. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 10. Nucleus with very flat dome-shaped spindle and cytoplasmic radiations or streams. Acid fuchsin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 11. Cell with centrosomes and distinct coarse radiations. Anilin-safranin, gentian-violet. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 12. Early dome-shaped spindle with no centrosomes visible. Iron-alum-haematoxylin. Zeiss oc. 12, obj. 2^{mm} ap. hom. im.

FIG. 13. Looped mother skein showing radiations around the poles of the dome-shaped spindle. Acid fuchsin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

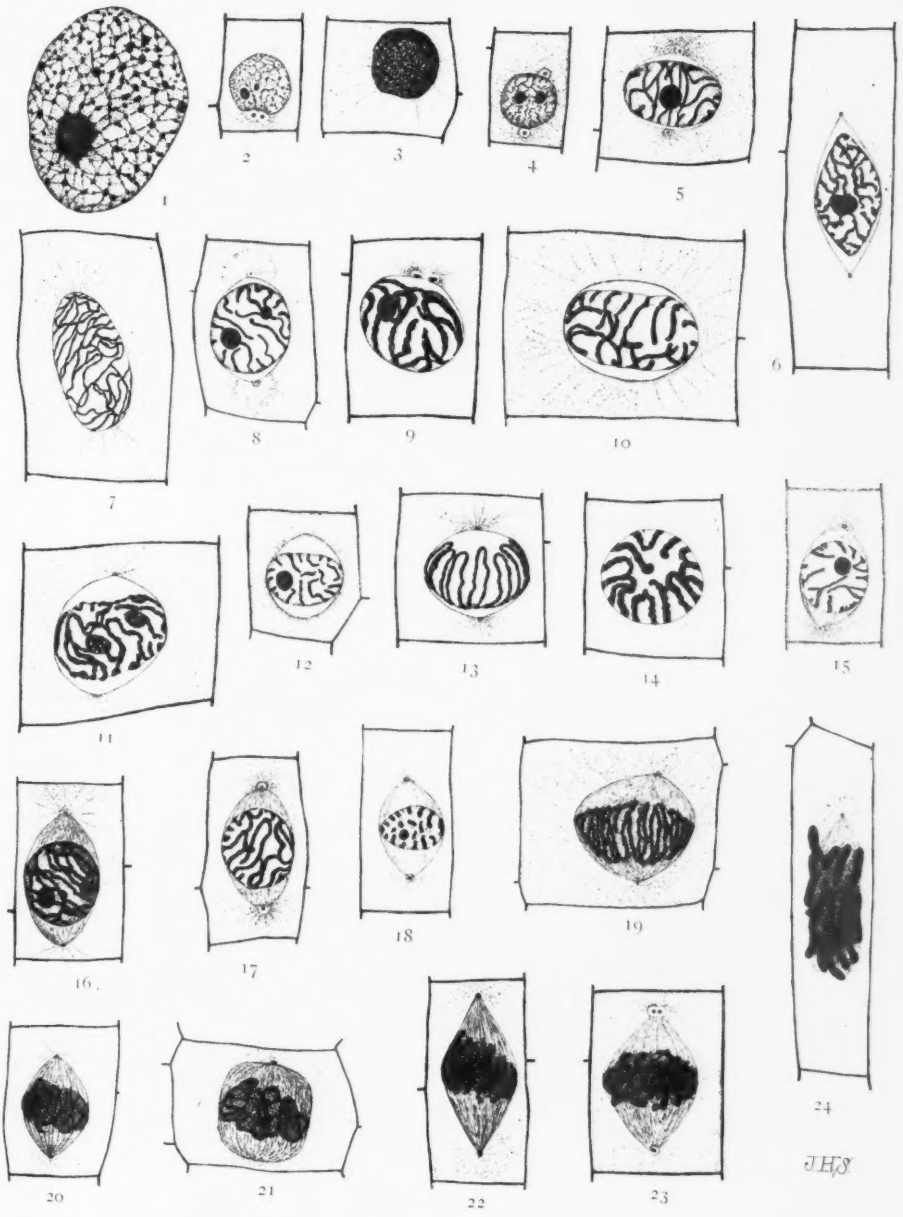
FIG. 14. End view of looped mother skein. Anilin-safranin, iron-alum-haematoxylin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 15. Dome-shaped spindle with centrospheres. Anilin-safranin, gentian-violet. Zeiss oc. 12, obj. 2^{mm} ap. hom. im.

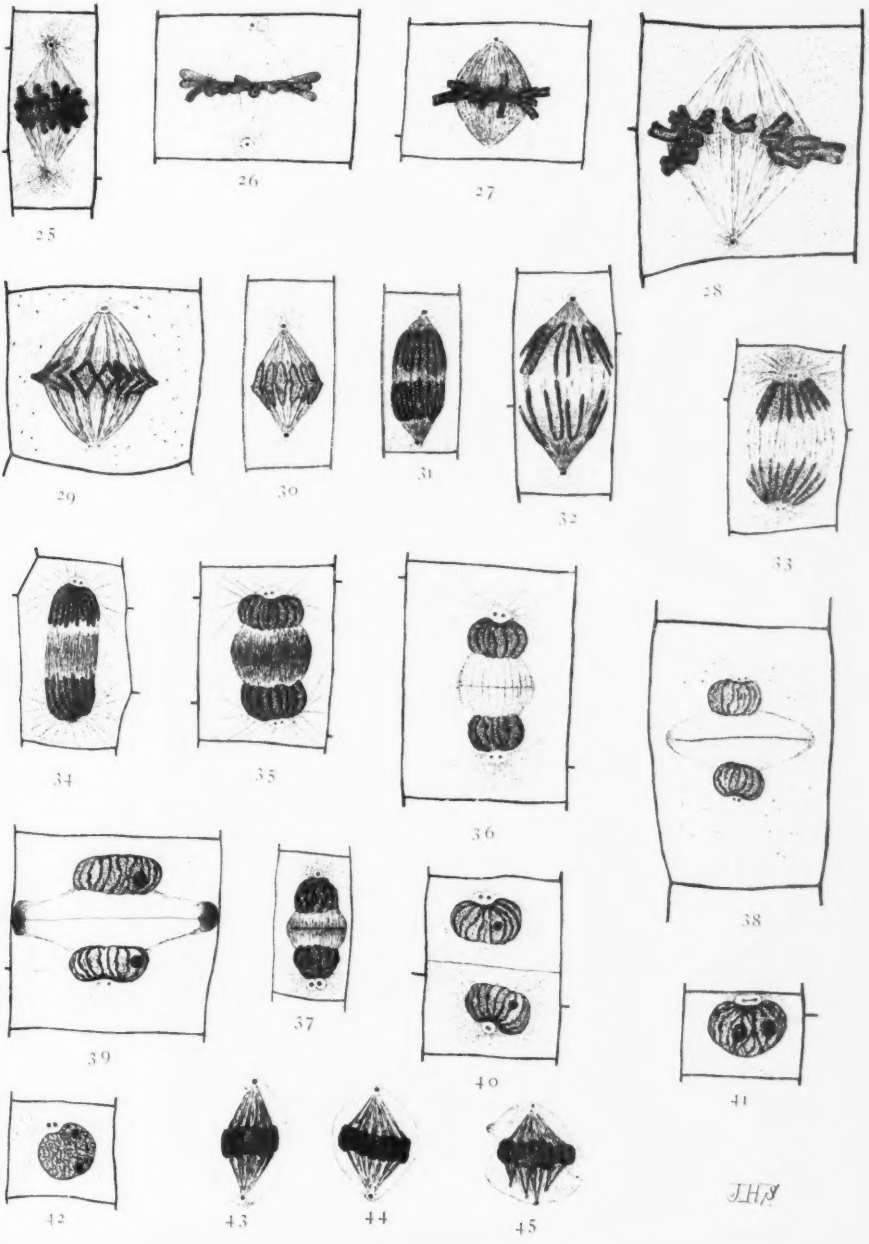
FIG. 16. Dome-shaped spindle becoming pointed, with prominent radiations around the poles. Anilin-safranin, iron-alum-haematoxylin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 17. Dome-shaped spindle with prominent centrospheres. Anilin-safranin, iron-alum-haematoxylin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 18. Spindle becoming pointed. Anilin-safranin, gentian-violet. Zeiss oc. 12, obj. 2^{mm} ap. hom. im.



SCHAFFNER on KARYOKINESIS.



SCHAFFNER on KARYOKINESIS.

FIG. 19. One-sided spindle with looped spirem. Anilin-safranin, iron-alum-haematoxylin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 20. Loose mother skein with centrosomes at the poles of the spindle. Iron-alum-haematoxylin. Zeiss oc. 12, obj. 2^{mm} ap. hom. im.

FIG. 21. A flat cell with a very flat spindle. One end shows a centrosome. Anilin-safranin, picric nigrosin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 22. Spindle much as in *fig. 20*, but more pointed. Anilin-safranin, gentian-violet. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 23. Loose mother skein with large centrospheres in which the centrosomes have divided earlier than usual. Anilin-safranin, gentian-violet. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 24. Long cell showing a sharp-pointed spindle with centrosphere and an outer granular zone in the radiations. Anilin-safranin, iron-alum-haematoxylin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

PLATE XXII.

FIG. 25. Loose mother skein showing spindle with typical centrospheres and radiations. Iron-tannin, safranin. Zeiss oc 12, B. and L. obj. $\frac{1}{12}$.

FIG. 26. Typical mother star. Anilin-safranin, gentian-violet, Gram's iodin potassium iodid. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 27. Segmented mother star. Acid fuchsin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 28. Segmented mother star from large cells of central strand. One end shows a very marked centrosome, the other none. Anilin-safranin, gentian-violet. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 29. Early stage of metakinesis with spindle still somewhat dome-shaped because of the flatness of the cell. Centrosomes divided. Anilin-safranin, picric nigrosin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 30. Metakinesis stage showing radiations around the poles. Anilin-safranin, gentian-violet. Zeiss oc. 12, obj. 2^{mm} ap. hom. im.

FIG. 31. Last stage of metakinesis; centrosomes dividing. Anilin-safranin, gentian-violet. Zeiss oc. 12, obj. 2^{mm} ap. hom. im.

FIG. 32. Daughter star stage; centrosomes dividing. Anilin-safranin, iron-alum-haematoxylin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 33. Daughter star. Prominent radiations around the poles. Anilin-safranin, gentian-violet. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 34. Beginning of loose daughter skein. Anilin-safranin, iron-alum-haematoxylin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 35. Loose daughter skein with coarse radiations. Gentian-violet, eosin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 36. Loose daughter skein with early stage of cell plate and prominent centrospheres. Anilin-safranin, gentian-violet, Gram's iodin potassium iodid. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 37. Loose daughter skein with prominent centrospheres. At the upper pole one centrosphere is hidden. Iron-tannin, anilin-safranin. Reichert oc. 12, Leitz obj. $\frac{1}{12}$.

FIG. 38. Loose daughter skein with large cell plate. Anilin-safranin, picric nigrosin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 39. Close daughter skein with cell plate about complete. Acid fuchsin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 40. Close daughter skein with cell plate complete. Anilin-safranin, iron-alum-haematoxylin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 41. Close daughter skein with dumb-bell-shaped centrosome delayed in division. Anilin-safranin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 42. Resting daughter cell with remarkably distinct centrospheres. Iron-alum-haematoxylin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 43. *Sagittaria variabilis*. Microspore grandmother cell showing spindle with large centrosomes. Anilin-safranin, iron-alum-haematoxylin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

FIG. 44. Same as *fig. 43*.

FIG. 45. *Sagittaria variabilis*. Microspore grandmother cell somewhat crushed, resulting in a distinct multipolar spindle. Centrosomes still visible. Anilin-safranin, iron-alum-haematoxylin. Zeiss oc. 12, B. and L. obj. $\frac{1}{12}$.

CELL DIVISION IN PINE SEEDLINGS.[1]

By EDWARD L. FULMER.

(WITH PLATES XXIII AND XXIV)

THE chief purpose of the following investigation was to determine the origin of the achromatic spindle, especially as to whether it originates as a bipolar or a multipolar structure. Along with this the subject of centrospheres was considered and also such other points of interest as might be observed in connection with karyokinesis.

The greater part of the work was done on *Pinus laricio* Poir., *P. silvestris* L. being used for comparison. The cell structures in the two species were found to be so nearly identical that it was not considered necessary to make any distinction between them in presenting the results of the investigation.

The material was obtained by sprouting the dry seeds, and when the embryos were from 0.5–3^{cm} long the root tips and cotyledons were cut off and killed in the usual manner. The fixing agents used were Flemming's stronger solution and chrom-acetic acid. The sections were imbedded in paraffin, and cut 10, 5, and 4 μ thick. Various combinations of stains were used; but the best results were obtained with analin-safranin gentian-violet, and orange G; iron-alum-hæmatoxylin; and Delafield's hæmatoxylin. The sections were usually stained so dark when killed in Flemming's solution that it was necessary to let them stand in turpentine exposed to the sunlight for some time in order to remove the black color which otherwise interfered greatly with the proper effect of the staining reagents. After this treatment the sections stained very well, and the details of protoplasmic structure were well differentiated.

My thanks are due to Dr. W. A. Kellerman and Mr. J. H. Schaffner for valuable assistance and criticism.

[1] Contribution from the botanical laboratory of Ohio State University. IV.

The cells of Pinus are moderately large and the karyokinetic figures distinct, but usually there is a considerable amount of oil present which is stained readily by most of the stains used, and thus interferes with the observation of the finer details of structure, especially with the centrospheres.

In the resting nucleus (*fig. 1*) the chromatin is arranged in a granular network with rather large meshes. Several nucleoli of various sizes are usually present, surrounded by hyaline areas. In normal cells of this stage no centrospheres were observed, although a diligent search was made for them. This might be taken to indicate that centrospheres are entirely absent in the resting stage, which would be contrary to the condition Schaffner[2] reported for *Allium Cepa*, where centrospheres are said to occur in resting cells as well as in the stages of division. However, the cytoplasm usually contained many oil drops and other granular contents so that if centrospheres were present they could not be distinguished very easily. In the outer layer, near the epidermis, elongated cells are sometimes found (*fig. 3*) which contain greatly elongated nuclei having spindle-like projections with bodies resembling centrosomes at the outer ends. Sometimes these bodies have radiations around them which make them strongly resemble the poles of a true spindle. Although the nucleus is in the resting stage the bodies might represent the poles of spindles which formed earlier than usual. However, the cells in this region seldom divide, and the phenomenon may be only an accompaniment of the elongation of the nucleus, the centrosome-like bodies representing accumulations of cytoplasm.

In the stele the elongated cells (*fig. 4*) contain very large nuclei having numerous nucleoli. In such cases the nucleoli are usually very large and filled with vacuoles. The nucleoli stain very dimly, so that the chromatin network is hardly visible even in well stained sections, while the nucleoli take a deep red stain with safranin, and are arranged in a line within the nucleus at somewhat regular intervals.

[2] BOT. GAZ. **19**: 445–459. 1894.

In some of the preparations very definite and distinct radiations surrounded the nuclei (*fig. 2*). These radiations are rather thick strands of cytoplasm, and do not show the fine structure found in spindle threads or in radiations around the poles. In the preparations where such radiations were seen nearly every cell showed them, whether in the resting condition or the early stages of division ; indicating that they were produced by the fixing agent. If not caused by this means they are probably the result of a streaming of the cytoplasm similar to that found in the cells of hairs on Tradescantia stamens.

Just before cell division commences the nuclei stain very readily. The first change to take place in the structure of the nucleus is the transformation of the chromatin network into a long thread or spirem. When the spirem is almost formed, and while the nucleoli are still visible in the nucleus, and before the nuclear membrane has disappeared, the spindle begins to form. When first seen it consists simply of two rounded or dome-shaped prominences (*fig. 5*), one on each side of the nucleus (*figs. 6–10*). These dome-shaped spindles gradually become elongated and pointed until they extend outward to two definite points at which centrosomes are often visible (*figs. 10–12*). These appear as small deeply stained bodies placed just at the point of the spindle (*figs. 24, 25*). In *fig. 16* the centrosome appears to be lying in a hyaline area which is surrounded by a darker portion of protoplasm. At about the time the spindle becomes pointed the spirem breaks into a definite number of chromosomes and the nuclear membrane disappears. At this time the nucleoli are no longer visible, having disappeared in the early prophase of division. They are not found again until cell division is about complete. The poles are usually approximately on opposite sides of the nucleus from the first appearance of the spindle. In a few cases, however, they were less than 180° apart (*fig. 12*), and did not become directly opposite until quite a late stage of karyokinesis. Radiations are frequently seen around the poles (*figs. 6, 11*).

F. Rosen[3] describes spindles quite similar to the above in the root tips of *Hyacinthus orientalis*. He finds the spindle arising as a cap-shaped prominence which is formed on two opposite points of the nucleus by the concentration of "kinoplasm" which had formed a hyaline area around the nucleus. This spindle originates before the dissolution of the nuclear membrane.

I examined carefully a large amount of material in search for radiations around the nuclei and for multipolar spindles in the prophases of karyokinesis as figured by Osterhout,[4] Mottier,[5] Juel,[6] and Debski,[7] but I was unable to find a single cell in these early stages that showed such structures. However, as above observed, in some preparations strands of cytoplasm were seen around the nuclei of nearly every cell. This was observed in cells both in the resting stage and during karyokinesis. These radiations were very coarse and could not, I think, be instrumental in spindle formation.

In some injured or sliced karyokinetic figures I found, though very rarely, spindles which appeared to be multipolar. The cells containing such spindles were all in the anaphase, mainly in the metakinesis and mother star stages (*fig. 21*), at which time the spindle is elongated and is more likely to be sliced in sectioning than those which are in other stages of karyokinesis.

In the material examined many cells were observed in the prophase, a large number of which showed definite spindles. In every case the spindle was bipolar, being short and rounded, or dome-shaped, when first visible near the nuclear membrane. The evidence furnished by my investigation is opposed to the theory that the spindle of Pinus originates as a multipolar structure.

With the segmenting of the spirem the metaphase begins. The spirem is scattered throughout the nucleus in the outer

[3] COHN'S Beiträge zur Biologie der Pflanzen **7**: 225–312. 1895.

[4] Jahrbücher fur wiss. Bot. **30**: 159–168. 1897.

[5] *Ibid.* **30**: 169–204. 1897.

[6] *Ibid.* **30**: 205–226. 1897.

[7] *Ibid.* **30**: 227–248. 1897.

part of the achromatin (*figs. 9–11*), and segments just before the spindle elongates to definite points. The nuclei in which I was able to count the segments contained sixteen chromosomes (*fig. 14*). They are somewhat difficult to count as they are usually massed together. Strasburger[8] counted twelve chromosomes in the pollen grain of *Pinus silvestris*. Dixon[9] found eight, twelve, and twenty-four chromosomes in the gametophyte of *Pinus silvestris*, with eight as the prevailing number. The nuclei in the primary meristem of the growing point of *Pinus Laricio* and *Picea orientalis* were found by the same author to contain sixteen chromosomes.

The chromosomes are at first scattered throughout the nucleus, but are gradually drawn toward the center to form the mother star (*fig. 15*). They seem to be arranged somewhat irregularly during this and the metakinesis stages (*figs. 15, 20, 22*). The longitudinal splitting of the chromosomes takes place about the time of the mother star stage. The daughter chromosomes then move toward the poles where they arrange themselves into the two daughter stars and form the network of the resting nuclei (*figs. 28, 29*). The spindle is usually quite pointed during metakinesis (*fig. 22*). Sometimes, however, when the cell is short, the spindle does not become pointed but remains dome-shaped (*fig. 18*), giving an appearance similar to that which would be produced by the spindle fibers passing through the cell wall. The centrosomes, however, show that the poles lie very close to the cell wall. *Fig. 17* shows one end of such a spindle with a double centrosome. In *fig. 24* the sides of the spindle are concave. This shape was probably produced by the protoplasm contracting near the lower end of the spindle. Radiations are more prominent during the anaphase than during either the earlier or later stages (*figs. 19, 23, 25*).

The centrosomes in Pinus appear as small but definite and readily stained bodies lying at the poles. Sometimes a hyaline area is visible around them in which the spindle threads termi-

[8] Ueber das Verhalten d. Pollens. Hist. Beitr. **4**: —. 1892.

[9] Ann. Bot. **8**: 21–34. 1894.

nate. In other cases no such area can be observed, the spindle fibers appearing to meet at the centrosome. These bodies, on account of their common occurrence at the poles, should perhaps retain the name of centrosomes whether they are permanent bodies directing cell division or whether they are only temporary structures. Whatever these bodies may be they certainly seem to be the same in character as the bodies found at the poles of cells in animal tissue. They are not only the points to which spindle fibers converge, but they are also the centers for a system of radiations which pass outward into the cytoplasm.

H. L. Smith[10] is perhaps the first to have figured centrosomes in plants. He found a small body in diatoms, especially in *Surirella splendens*, which he called the germinal dot. This was no doubt a centrosome. Guignard[11] figured and described these bodies in resting cells as well as during karyokinesis. In his recent paper[12] he finds centrosomes in all phases of nuclear division in *Nymphæa alba*. He finds multipolar spindles also in *Nuphar luteum*, and says they are very frequent in *Limodorum abortivus*, but he does not give any explanation of their origin.

In the early part of the telophase the cell wall between the two daughter nuclei begins to form. It starts as a granular thickening of the middle of the central spindle fibers (*fig. 26*). This thickening gradually extends outward and the spindle at the same time gradually increases in diameter (*figs. 27, 28*) until its middle portion touches the cell walls. The cell plate then completely divides the daughter cells and the spindle soon disappears. In *fig. 28* traces of it may still be seen. Two centrosomes are now found at each pole, the single ones having divided. While the network is being formed the daughter nuclei change from an oval to a spherical form, sometimes having radiations around them (*fig. 29*).

COLUMBUS, O.

[10] A contribution to the life history of Diatomaceæ, Proceedings American Society of Microscopists **1886**: 1–37.

[11] Ann. Sci. Nat. (Bot.) VII. **14**: 163–296. 1891.

[12] BOT. GAZ. **25**: 158–164. 1898.

EXPLANATION OF PLATES XXIII, XXIV.

The figures were drawn with combinations of Zeiss and Bausch and Lomb objectives and oculars by the aid of a camera lucida, and are reduced to about $\frac{3}{8}$ of their original size. The initial letter of the objectives and oculars are used to designate them. The four following combinations were employed: Z 2^{mm} ap. Z 18 (× 2250); Z 2^{mm} ap. Z 12 (× 1500); B & L $\frac{1}{12}$ Z 12 (× 2600); B & L $\frac{1}{12}$, B & L $\frac{3}{4}$ (× 1400).

Figures 1, 16, 17, 18, 26, and 29 were taken from *Pinus silvestris;* all the others from *Pinus Laricio.*

PLATE XXIII.

FIG. 1. Resting nucleus with large oil drops in the cytoplasm. B & L $\frac{1}{12}$ Z 12.

FIG. 2. Resting cell, with radiating streams of cytoplasm around the nucleus. B & L $\frac{1}{12}$; B & L $\frac{3}{4}$.

FIG. 3. Resting cell containing an elongated nucleus with a spindle and centrosome-like bodies. Z 2^{mm} ap. Z 18.

FIG. 4. Part of cell containing a very large nucleus in which are several nucleoli with vacuoles. B & L $\frac{1}{12}$ Z 12.

FIG. 5. Early stage of division showing first appearance of spindle. B & L $\frac{1}{12}$ Z 12.

FIG. 6. Spindle elongating showing centrosomes and radiations. B & L $\frac{1}{12}$ Z 12.

FIG. 7. Same stage, somewhat later, showing few radiations. B & L $\frac{1}{12}$ Z 12.

FIG. 8. Dome-shaped spindle showing neither centrosomes nor radiations. B & L $\frac{1}{12}$ Z 12.

FIG. 9. Dome-shaped spindle showing centrosomes and a few radiations. B & L $\frac{1}{12}$ Z 12.

FIG. 10. Same stage more advanced. Z 2^{mm} ap. Z 12.

FIG. 11. Spindle becoming pointed showing centrosomes and radiations. Z 2^{mm} ap. Z 18.

FIG. 12. Spindle pointed but poles not entirely opposite. B & L $\frac{1}{12}$ Z 12.

FIG. 13. Nuclear membrane absent; spindle not so much pointed as is usual at this stage. B & L $\frac{1}{12}$ Z 12.

FIG. 14. Loose mother skein stage showing appearance and number of chromosomes. Z 2^{mm} ap. Z 18.

PLATE XXVI.

FIG. 15. Mother star stage. B & L $\frac{1}{12}$ Z 12.

FIG. 16. Showing one end of spindle with a large centrosome; chromosomes massed together. Z 2^{mm} ap. Z 12.

FIG. 17. Same as above with pole of spindle near cell wall. Z 2^{mm} ap. Z 12.

FIG. 18. Metakinesis; poles of spindle crowded against cell walls. Z 2^{mm} ap. Z 12.

FIG. 19. Metakinesis; pole with centrosome and distinct radiations. B & L $\frac{1}{12}$ Z 12.

FIG. 20. Metakinesis. Z 2^{mm} ap. Z 12.

FIG. 21. Metakinesis; injured, showing multipolar spindle; chromosomes are partly displaced. B & L $\frac{1}{12}$ Z 12.

FIG. 22. Metakinesis. B & L $\frac{1}{12}$ Z 12.

FIG. 23. Near close of metakinesis, showing centrosomes and radiations. Z 2^{mm} ap. Z 12.

FIG. 24. Same as above. Z 2^{mm} ap. Z 12.

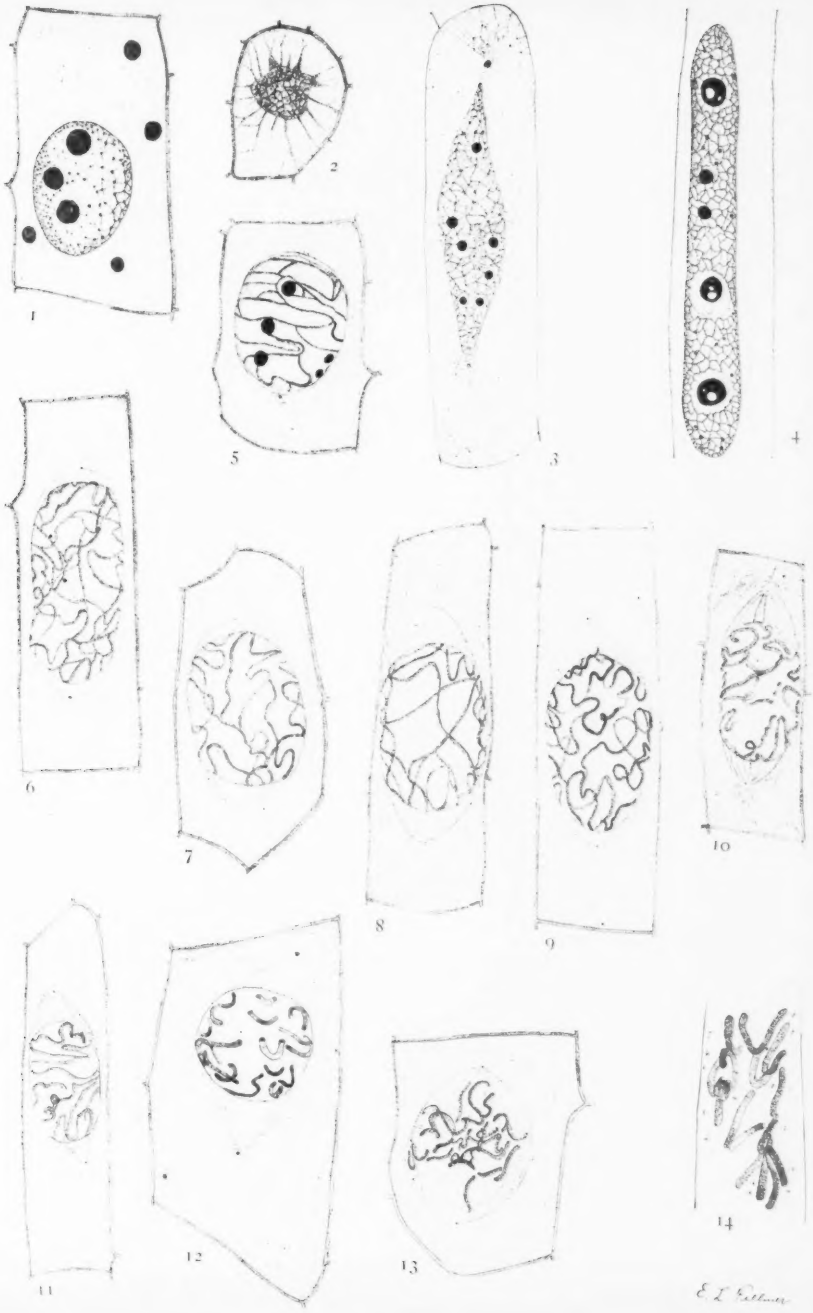
FIG. 25. Daughter star with centrosomes and radiations. B & L $\frac{1}{12}$ Z 12.

FIG. 26. Loose daughter skein. B & L $\frac{1}{12}$ Z 12.

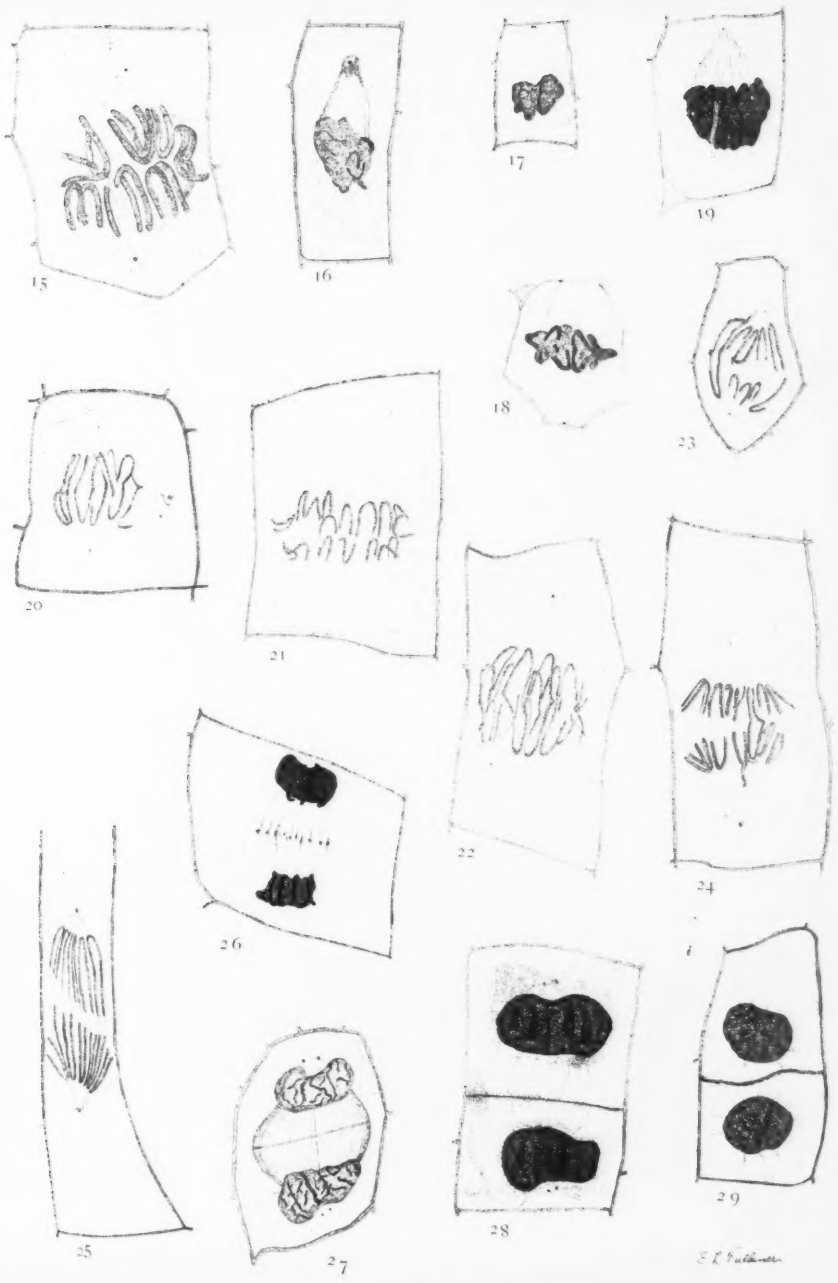
FIG. 27. Close daughter skein; cell plate formed. Z 2^{mm} ap. Z 18.

FIG. 28. The same but somewhat more advanced. Z 2^{mm} ap. Z 18.

FIG. 29. Near end of close daughter skein; nuclei are becoming globular. B & L $\frac{1}{12}$ Z 12.



FULLMER on CELL-DIVISION.



FULLMER on CELL-DIVISION.

POPULAR AMERICAN PLANT-NAMES. V.

FANNIE D. BERGEN.

LOBELIACEÆ.

Lobelia cardinalis, L., queen-of-meadow, Southold, L. I.

CAMPANULACEÆ.

Campanula Americana, L., hibelia (*i. e.* high lobelia),[1] Sulphur Grove, Ohio.

ERICACEÆ.

Andromeda ligustrina, Muhl., maleberry, York, Me.
Arctostaphylos Andersonii, Gray, little apple, manzanita, Cal.
Azalea viscosa, L., June pink, N. H.
Chimaphila maculata, Pursh., wax flower, Southold, L. I.
Chimaphila umbellata, Nutt., wintergreen, Oxford County, Me.
Chiogenes serpyllifolia, Salisb., Moxa or Moxie, Paris and Dixfield, Me.
running tea, Bethel, Me.
sugar-berry (locality ?).
spice-berry, tea-berry, New Brunswick.
Epigæa repens, L., shad-flower, New England and New Jersey.
real mayflower,[2] Norridgewock, Me.
Gaylussacia ursina, T. and G., bear huckleberry, Mountains of New England.
Kalmia latifolia, L., sheepsbane, Long Island.
ivy, West.
Ledium latifolium, Ait., Labrador, Paris, Me.
gowiddie, Newfoundland.
Monotropa uniflora, L., ghost-flower, S. Berwick, Me.
Rhododendron Rhodora, Don, laurel, Paris, Me.
Sarcodes sanguinea, Torr., snow plant, Sierra Nevada, Cal.
Vaccinium ovatum, Pursh., California huckleberry, Cal.

PRIMULACEÆ.

Anagallis arvensis, L., poison chickweed, Cal.
red chickweed, West.
Dodecatheon Meadia, L., cyclamen, Ala.
Lysimachia nummularia, L., money plant, infant's breath, Oxford Co., Me.
money-bags, Medford, Mass.

[1] Spokes of flowers seen from afar resemble those of *Lobelia syphilitica*.
[2] The hepatica is called mayflower in Norridgewock, Me.

Primula Mistassinica, Michx., drip-primrose, Harding's "With the Wild Flowers," p. 214.
Primula officinalis, Jacq., tuberose, Colo.
Trientalis Americana, Pursh., Star of Bethlehem, Fairhaven, Mass., and Vermont.

SAPOTACEÆ.

Mimusops Sieberi, A. DC., wild sapodilla, Florida keys.

OLEACEÆ.

Fraxinus pubescens, Lam., yellow ash, West.

APOCYNACEÆ.

Apocynum androsæmifolium, L., Chickasaw, wildweed, Paris and Hartford, Me.
Vinca minor, L., myrtle, Paris, Me.
myrtle, wintergreen, Sulphur Grove, Ohio.

ASCLEPIADACEÆ.

Asclepias tuberosa, L., swallow wort, West.
pleurisy root, chigger[1] flower, Southwestern Mo.
Enslenia albida, Nutt., honey-vine, Tex.

GENTIANACEÆ.

Erythræa Douglassi, Gray, Canchalagua, chill and fever plant, Cal.
Menyanthes trifoliata, L., marsh trefoil, West.
Sabbatia angularis, Pursh., Texas star, Tex.

POLEMONIACEÆ.

Gilia coronopifolia, Pers., standing cypress, Ala.
Texas plume, Tex.
Phlox ovata, L., sweet William, Sulphur Grove, Ohio.
Phlox pilosa, sweet William,[2] Mo.
Phlox subulata, L., moss pink, creeping phlox, Sulphur Grove, Ohio.
Phlox (all species), sweet William, Ind.
Polemonium reptans, L., snake root, blue valerian, Parke County, Ind.

HYDROPHYLLACEÆ.

Emmenanthe penduliflora, Benth., yellow bells, Cal.
Eriodictyon glutinosum, Benth., mountain balsam, yerba santa, Cal.
Nemophila insignis, Dougl., baby-blue-eyes, Cal.
Phacelia tanacetifolia, Benth., tansy-leaf phacelia, Cal.

[1] From a popular belief that the insect of that name is found there.

[2] *Phlox pilosa* and related species are confounded with *Verbena Aubletia*, and all called sweet William in southwestern Missouri.

BORRAGINACEÆ.

Amsinckia (five species), tar weed, Cal.
Cynoglossum (all species), beggar lice, Sulphur Grove, Ohio.
Echinospermum floribundum, Lehm., stick weed, Cal.
Echinospermum Lappula, Lehm., forget-me-nots, Madison, Wis.
Echinospermum Virginicum, Lehm., beggar ticks,[1] Southwestern Mo.
Echium vulgare, L., blue weed, Jackson County, Mo.
Lithospermum canescens, Lehm., blood root, Indian paint,[2] Southwestern Mo.
Myosotis, sp., scorpion weed, West.
Symphytum asperrimum, Sims, bugloss, Paris, Me.

CONVOLVULACEÆ.

Convolvulus sepium, L., Rutland beauty, Kentucky hunter, pea vine, Sulphur Grove, Ohio.
Kentucky hunter, Paris, Me.
Cuscuta, sp., love vines,[3] Southwestern Mo.
corn silk, Southold, L. I.
Cuscuta Gronovii, Willd., angels' hair, La.
Ipomœa hederacea, Jacq., blue morning glory, Southwestern Mo.
Ipomœa leptophylla, Torr., wild potato vine, man of the earth, morning glory bush, Cal.
Ipomœa pandurata, Mey., and *Convolvulus sepium*, L., wild potato, Southwestern Mo.
Ipomœa pandurata,[4] Mey., wild potato, Ala.
wild sweet potato, pea vine, Sulphur Grove, Ohio.
Ipomœa purpurea, Lam., red morning glory, Southwestern Mo.

SOLANACEAE.

Datura meteloides,[5] DC., Jamestown weed, thorn apple, Cal.
Lycium vulgare, Dunal., Washington's bower, Southwestern Mo.
Nicandra physaloides, Gaertn., globe, Sulphur Grove, Ohio.
Nicotiana glauca, Graham, tobacco tree, Cal.
Physalis, sp., cherry tomatoes, Eastern end of Long Island.

[1] Confounded with *Galium*.

[2] From a tradition that the Indians thus utilized its root.

[3] From a popular custom among young people of throwing a portion of this plant backward over the head of another plant, and naming it for some one. If it lives, that one loves them.

[4] Sold by J. Lewis Childs, Floral Park, N. Y., under the name of "hardy tuberous-rooted moonflower."

[5] The seed is made into an intoxicating drink by the Arizona Indians.

Solanum Carolinense, L., bull nettle, Southwestern Mo.
Solanum Dulcamara, L., myrtle vine, Sulphur Grove, Ohio.
wood nightshade, West.
Solanum nigrum, L., bonewort, West.
Solanum radula, Vahl, soap berry, Florida keys.
Solanum rostratum, Dunal., Kansas thistle, Southwestern Mo.
Solanum triquetrum, Cav., potato jasmine, Waco, Tex.
Solanum verbascifolium, L., mugged (? mug-weed, mug-wood, mug-wort), Florida keys.

SCROPHULARIACEÆ.

Castilleia sessiliflora, Pursh., honeysuckle, Burnside, S. Dak.
Linaria vulgaris, Mill., Jacob's ladder, Long Island.
ladies' slippers, Mass.
butter and eggs, Auburndale and Cambridge, Mass.
Pedicularis Canadensis, L., chickens' heads, Southold, L. I.
Pentstemon Digitalis, Nutt., dead men's bells,[1] West.
Pentstemon gracilis, Nutt., beard-tongue, Greene County, Mo.
Pentstemon, sp., foxglove, Tex.
Scrophularia nodosa, var. *Marilandica*, Gr., carpenter's square, Southwestern Mo.
Verbascum Blattaria, L., slippery mullein (in distinction from fuzzy mullein, *V. Thapsus*), Southold, L. I.
Veronica Virginica, L., black root, Southwestern Mo.
Veronica, sp., speedwell or brooklime, Harding's "With the Wild Flowers."

OROBANCHACEÆ.

Aphyllon or *Boschniakia*, sp., squirrels' grandfather, Cal.

BIGNONIACEÆ.

Chilopsis saligna, Don, desert willow, Ariz. and Colo.
catalpa willow, Tex.

VERBENACEÆ.

Avicennia oblongifolia, ? Nutt., black wood, Florida keys.
Calicarpa Americana, L., French mulberry, Miller County, Mo.
Lantana involucrata, L., var. Floridana, sage tree, Florida keys.
Lippia cuneifolia, Steud., chapparal, Mexican heliotrope, Tex.
Verbena Aubletia, L., sweet William,[2] Southwestern Mo.
Verbena angustifolia, *stricta*, and *urticæfolia*, L., bur-vine, Southwestern Mo.
Verbena stricta, Vent., thimble-weed, St. Joseph, Mo.

[1] From growing on graves.
[2] Flowers have a sweetish taste when eaten, like the flowers of phlox.

LABIATÆ.

Brunella vulgaris, L., wild sage, Paris, Me.
hearts' ease, Cambridge, Mass.
cure-all, West.

Galeopsis Tetrahit, L., Keays-weed, Bisbee-weed, bur-weed, Paris, Me.

Hedeoma pulegioides, Pers., pudding grass, West.

Lycopus sinuatus, Ell., rattlesnake weed,[1] Southwestern Mo.

Lycopus Virginicus, L., archangel, Dixfield, Me.
sprig-of-Jerusalem, South Berwick, Me.

Mentha Canadensis, L., wild bergamot, or bergamont, Oxford County, Me.

Mentha piperita, L., manzania, Cal.

Micromeria Douglasii, Benth., good herbs, "yerba buena," Cal.

Molucella lævis, L., Molucca balm, shell flower, old maids' bonnet, Sulphur Grove, Ohio.

Nepeta Glechoma, Benth., Gill-run-over-grass, run-away-Jack, blue bells, Cambridge, Mass.
run-away-Nell, Medford, Mass.

Origanum vulgare, L., wild marjoram, West.

Salvia Columbariæ, Benth., wild sage, chia, winter oat, Cal.

Scutellaria laterifolia, L., hoodwort, West.

Teucrium Canadense, L., betony, head betony, wood betony, West.

PLANTAGINACEÆ.

Plantago lanceolata, L., nigger-heads, hock cockle, Southold, L. I.
soldiers, Cambridge, Mass.

NYCTAGINACEÆ.

Abronia latifolia, Esch., yellow sand verbena, Cal.

Boerhaavia erecta, L., jigger weed, Florida keys.

Mirabilis Jalapa, L., pretty-per-night,[2] Sulphur Grove, Ohio.

AMARANTACEÆ.

Amarantus Albus, L., tumble weed,[3] Southwestern Mo.

Amarantus retroflexus, L., light-houses,[4] Southold, L. I.
curls, red root, Sulphur Grove, Ohio.
wild beet,[5] Oxford County, Me.

[1] Herb said to be an antidote for the bite of rattlesnakes.
[2] Not pretty by night, although it means the same.
[3] From its habit of drying in a round mass, and being rolled about by the wind.
[4] From speed with which they tower above crops in the fields.
[5] Said to taste like beets when cooked for "greens."

Gomphrena globosa, L., globe amaranth, bachelor's button, Sulphur Grove, Ohio.
bachelor's button, Ala.

CHENOPODIACEÆ.

Chenopodium album, L., black weed,[1] Eastern Long Island.
Chenopodium capitatum, Watson, garden strawberry, Paris, Me.
Salicornia ambigua, Michx., lead grass, lead weed,[2] Southold, L. I.

PHYTOLACCACEÆ.

Phytolacca decandra, L., poke berry, poke root,[3] Sulphur Grove, Ohio.
cocum, pocum, pigeon berry, West.
ink bush, ink-berry bush, Southold, L. I.
haystack weed, Conn.

POLYGONACEÆ.

Polygonum aviculare, L., dog-tails, St. Joseph, Mo.
Polygonum convolvulus, L., wild bean, Oxford County, Me.
Polygonum dumetorum, L., var. *scandens*, Gray, wild buckwheat, Burnside, S. Dak.
Polygonum erectum, L., goose grass, Sulphur Grove, Ohio.
Polygonum orientale, L., Gentleman's cane, prince's feather, Sulphur Grove, Ohio.
kiss-me-over-the-fence, Sulphur Grove, Ohio.
ragged sailor, Paris, Me.
Polygonum Persicaria, L., heart weed, Oxford County, Me.
black heart, Lubec, Me.; Mass.; Southern Vt.
Polygonum terrestre, heartsease, Nebr.
Polygonum (twining species), pull-down, blind weed, Sulphur Grove, Ohio.
Polygonum, sp., heart's ease, Erie County, Pa.
Rheum Rhaponticum, L., wine plant, Sulphur Grove, Ohio.
Rumex crispus, L., narrow dock, curled dock, Sulphur Grove, Ohio.
Rumex obtusifolius, L., sour dock, poison dock, Sulphur Grove, Ohio.

ARISTOLOCHIACEÆ.

Asarum Canadense, L., colt's foot, West.

CAMBRIDGE, MASS.

[1] Because it stains the fingers black.
[2] From its weight in the salt-meadow hay.
[3] The friends of J. K. Polk used this plant as their symbol when he was running for president, and marked their hats with juice of the berries.

POPULAR AMERICAN PLANT-NAMES. VI.

FANNIE D. BERGEN.

LAURACEÆ.

Umbellularia Californica, Nutt., pepper-wood, Cal.

THYMELÆCEÆ.

Dirca palustris, L., Indian wickape, West.
wickopy, Hartford, Me.

ELÆAGNACEÆ.

Shepherdia argentea, Pursh, buffalo berry, Nebr.

EUPHORBIACEÆ.

Euphorbia corollata, L., milkweed, Madison, Wis.
Euphorbia Cyparissias, L., milkweed, Vermont.
graveyard moss, Ind.
Euphorbia hypericifolia, and *E. maculata*, L., corn-pusley, Southold, L. I.
Euphorbia maculata, L., French pursley, Sulphur Grove, Ohio.
Euphorbia marginata, Pursh, snow-on-the mountain, Sulphur Grove, Ohio; N. Dak.
milkweed, ghost-weed, snow-on-the-mountain, Waco, Tex.
Jatropha stimulosa, Michx., bull nettle, South.
Ricinus communis, L., castor-bean, Sulphur Grove, Ohio.
Simmondsia Californica, Nutt., pig-nut, Arizona.
Tragia nepetæfolia, Cav., stinging nettle, Southwestern Mo.

URTICACEÆ.

Laportea Canadensis, Gaudich, wood nettle, Southwestern Mo.
Maclura aurantiaca, Nutt., Osage orange, hedge-tree, "bois d'arc," Southwestern Mo.
Pilia pumila, Gray, water weed, Sulphur Grove, Ohio.
Ulmus Americana, L., red elm, white elm, Southwestern Mo.
Ulmus fulve, Michx., slippery elm, white elm, Southwestern Mo.

JUGLANDACEÆ.

Carya alba, Nutt., walnut, New England.
black hickory, Southwestern Mo.
Carya microcarpa, Nutt., black hickory, Sulphur Grove, Ohio.
Carya porcina, Nutt., spignut,[1] Ind.

[1] A corruption of pignut.

Carya sulcata, Nutt., shell-bark hickory, Southwestern Mo.
Carya tomentosa, Nutt., white hickory, Southwestern Mo.
pull-nut, mocker-nut, Sulphur Grove, Ohio.
Juglans cinerea, L., oil-nut tree, West.
white walnut, Southwestern Mo.

CUPULIFERÆ.

Betula balsamifera, sycamore, black poplar, West.
Carpinus Caroliniana, Walt., swamp beech, hornbeam, Sulphur Grove, Ohio.
Fagus ferruginea, Ait., white beech, red beech, black beech, West.
Quercus coccinea, Wang., and var. *tinctoria*, Gray, black oak, Southwestern Mo.
Quercus imbricaria, Michx., swamp oak, pin oak, Southwestern Mo.
Quercus rubra, L., red oak, Spanish oak (lowland variety), Southwestern Mo.

SALICACEÆ.

Salix cordata, Muhl., var. *vestita*, And., diamond willow, Burnside, S. Dak.
Salix, sp., with catkins very prominent, pussy willow, Sulphur Grove, Ohio.

EMPETRACEÆ.

Empetrum nigrum, L., squirt plum, Rumford, Me.

CONIFERÆ.

Abies alba, Link, cat spruce, Andover, Me.
Juniperus communis, L., juniper, West.
Juniperus Sabina, L., juniper, West.
Juniperus Virginiana, L., juniper, West.
Larix Americana, Michx., juniper, West.
cypress, Oxford County, Me.
Pinus Banksiana, Lambert, shrub pine, West.
Pinus resinosa, Ait., Norway pine, hard pine, Oxford County, Me.
Pinus strobus, L., yellow pine, West.
Torreya Californica, Torr., California nutmeg tree, Cal.

ORCHIDACEÆ.

Arethusa bulbosa, L., swamp pink, meadow pink, Mass.
Cypripedium acaule, Ait., valerian, nerve root, Paris, Me.
Indian slipper, Oxford County, Me.
Cypripedium spectabile, Swartz, shepherd's purse, Lepreau, N. B.
Goodyera repens, R. Br., adder's tongue, Paris, Me.
Habenaria psycodes, Gray, and *Habenaria fimbriata*, R. Br., wild hyacinth, Woodstock, Me.
Spiranthes cernua, Richard, hens' toes, Paris, Me.

IRIDACEÆ.

Iris versicolor, L., blue lily, Madison, Wis.
Sisyrinchium angustifolium, Mill., forget-me-not, Hartford, Me.

AMARYLLIDACEÆ.

Agave Parryi, Engelm., century plant, Ariz.
Cooperia Drummondii, Herb., rain lilies, star flowers, Waco, Tex.
Narcissus (all species), Easter flowers, Sulphur Grove, Ohio.

LILIACEÆ.

Camassia esculenta, wild hyacinth, "kmass," Cal.
Chlorogalum pomeridianum, Kunth, soap root, soap plant,[1] "amole," Cal.
Clintonia borealis, Raf., hound's tongue, calf corn, Hartford, Me.
wild corn, corn flower, Oxford County, Me.
Dasylirion Wheeleri, Watson, bear grass, Ariz.
Erythronium albidum, Nutt., tulip, Southwestern Mo.
Erythronium Americanum, Ker., wild yellow lily, Norridgewock, Me.
jonquil, cornflower,[2] Oxford County, Me.
Hemerocallis flava, L., lemon lily,[3] Sulphur Grove, Ohio.
Hesperocallis undulata, Gray, California day lily, Cal.
Lilium Philadelphicum, L., freckled lily, South Berwick, Me.
Maianthemum bifolium, DC., wild lily of the valley, Fairhaven, Mass.
Muscari racemosum, Mill., var. *plumatilis*, feather hyacinth, sugar loaf, Sulphur Grove, Ohio.
Oakesia sessilifolia, Watson, wild oats, Paris and Hartford, Me.
corn-flower, Oxford County, Me.
Smilax Bona-nox, L., bamboo vine, stretch-berry, Waco, Tex.
Smilax rotundifolia, L., horse brier, dog brier, Mass.
Streptopus roseus, Michx., Jacob's ladder, Paris, Me.
Solomon's seal, West.
Trillium erectum, L., red Benjamin, Woodstock and Paris, Me.
wild peony, or "piny," Oxford County, Me.
Trillium erythrocarpum, Michx., white Benjamin, Woodstock and Paris, Me.
Trillium recurvatum, Beck., cowslip, Parke County, Ind.
Jack-in-the-pulpit, Central Ill.
Trillium sessile, L., nigger-heads, Ind.

[1] Used in washing.
[2] Sometimes used for "greens."
[3] Lemon-colored.

Veratrum viride, Ait., Indian poke, Oxford County, Me.
Xyrophyllum setifolium, Michx., turkey-beard, N. J.
Yucca filamentosa, L., Adam's needle and thread, Harding's "With the Wild Flowers."
Yucca gloriosa, L., Roman candle, the Lord's candlestick, So. Cal.

PONTEDERIACEÆ.

Pontederia cordata, L., moose-ear, Grand Lake, N. B.

COMMELINACEÆ.

Tradescantia crassifolia (green), Jacob's ladder, Wandering Jew, Sulphur Grove, Ohio.
(striped), Joseph's coat, Sulphur Grove, Ohio.
Tradescantia, sp., in greenhouses, small white flowers pointed like corn, corn lily, Sulphur Grove, Ohio.
Tradescantia, sp., Indian paint,[1] Mineral Point, Wis.

ARACEÆ.

Arisæma triphyllum, Torr., wake-robin, West.
bog onion, Rumford, Me.
memory root, Rutland, Mass.
Calla palustris, L., water arum, West.

ALISMACEÆ.

Sagittaria variabilis, Engelm., water lily, Southwestern Mo.
arrow-head, swan root,[2] Cal.

CYPERACEÆ.

Cyperaceæ (all grass-like species), ornamental grass, Sulphur Grove, Ohio.
Scirpus lacustris, L., cat-tail flag,[3] Cal.

GRAMINEÆ.

Agropyrum repens, L., witch grass, Oxford and York counties, Me.
Andropogon furcatus, Muhl., and related species, blue-stem grass, Southwestern Mo.
Cenchrus tribuloides, L., sand spur, Fla.
sand bar, Waco, Tex.
Danthonia spicata, Beauv., witch grass, Oxford and York counties, Me.

[1] The juice said to irritate the skin and make it red.
[2] Used as food by Indians.
[3] Used as food by Indians.

Panicum capillare, L., tickle grass, Sulphur Grove, Ohio.
Panicum virgatum, L., switch grass,[1] Central Neb.
Setaria glauca and *viridis*, Beauv., barn grass, Oxford County, Me.
Sorghum, sp., cane, sugar cane, Sulphur Grove, Ohio.
Sporobolus Buckleyi, Vasey, crawly grass,[2] tickle grass, Waco, Tex.
Sporobolus serotinus, Gray, blue ruin, Oxford County, Me.
Triticum repens, twitch grass, dog grass, Oxford County, Me.
Zea mays, L. (yellow striped with red), bloody butcher, Sulphur Grove, Ohio.
(hard grains without dents), flint corn, Sulphur Grove, Ohio.

EQUISETACEÆ.

Equisetum hiemale, L., gun-bright,[3] Penobscot County, Me.
snake weed, Jones and Delaware counties, Iowa.

FILICES.

Aspidium Noveboracense, Swartz, bear's paw, Plattsburg, N. Y.
Cystopteris, sp., bladder fern, N. Y.
Onoclea sensibilis, L., polypod brakes,[4] Oxford County, Me.
sugar brake, Penobscot County, Me.
Polypodium (a Florida species), resurrection fern,[5] Fla.
Pteris aquilina, L., poor man's soap,[6] Ala.
Woodwardia, sp., chain fern, N. Y.

OPHIOGLOSSACEÆ.

Botrychium Virginianum, Swartz, indicator,[7] Jackson, West Va.

LYCOPODIACEÆ.

Lycopodium clavatum, L., stag-horn evergreen, Concord, Mass.
Lycopodium complanatum, L., trailing Christmas Green, West Va.
trailing, running, or creeping vine, Ferrisburgh, Vt.
evergreen, Oxford County, Me.
Lycopodium, sp., fox-tail, St. Andrews, N. B.

[1] Also called "wild red-top" by the farmers.
[2] Very troublesome to the mower, eluding the scythe.
[3] Said to have been used by the Indians for polishing their guns.
[4] It would be an interesting investigation to trace out the origin of this application of a name evidently derived from *Polypodium*.
[5] From its habit of unrolling upon being wet with rain.
[6] Because it will make a lather with water.
[7] Name derived from the fact that its growth is thought to indicate the presence of ginseng.

MUSCINEÆ.

Polytrichum commune, bear's grass, Penobscot County, Me.
bird's wheat, Kennebec valley, Me.

FUNGI.

Boletus, sp., cow mushroom, N. H.
Exobasidium, sp., May apple, N. J.
Phallus, sp., carrion flower, Mass.

ALGÆ.

Spirogyra, sp., frog slime, N. H.
Ulva latissima, glit, Mace's Bay, N. B.

CAMBRIDGE, MASS.

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OBSERVATIONS UPON THE NEWER BOTANY.[1]

BYRON D. HALSTED.

THE LEAF A LIGHT-RELATED ORGAN.

UNDER life relations it may be an advantage to some that an instance be stated even though it be in brief terms. Let us take the leaf as it is, one of the three vegetative organs.

The leaf is divided into three parts—the stalk, stipules, and blade. Furthermore, the blade is made up of the framework, the pulp, and the skin that envelops all and holds the parts together. It has been stated that the leaf is a light-related organ, and it will be to the point to consider this relationship.

It is the pulp that interests us in considering the leaf as related to the light, and this is the soft portion lying between the upper and lower skin, and supported by the framework. It consists of minute cells somewhat loosely placed.

It is now that the microscope lends valuable assistance, for by it it is seen that the cells consist of three parts, the wall or sac, the liquid, and the green granular contents.

It is these minute masses of protoplasm, colored green by chlorophyll that interest us in a study of the light relation, for it is in these that the energy of motion is transformed into energy of position—kinetic into potential.

Within these chlorophyll granules the energy of the vibrating rays of the sun splits up the molecules of water, coming from the soil through the roots and stem, and those of the carbonic dioxide from the atmosphere driving off a portion of the oxygen. Thus, if we should have six groups of the carbon dioxide molecules ($6\ CO_2$) and five of water ($5\ H_2O$) there might be a separation of twelve atoms of oxygen, and the union

[1] Remarks following a paper upon Botany for the Secondary Schools, by Dr. J. M. Coulter, before the Natural Science Section of the National Educational Association, Washington, D. C., July 1898.

of the remaining portion would give a molecule of starch ($C_6 H_{10} O_5$). This is food making reduced to its simplest terms, and the chlorophyll granules that float in the semi-liquid plasma are the centers of synthesis of organic compounds.

Each starch granule, whether of wheat, potato, sago, or rice, represents a potential energy that may remain unnoticed until the occasion for oxygen to unite again with the elements in the compound when it ceases to exist as starch, and with the liberation of sensible energy carbon dioxide and water result. In other words, the sun's force raises the inorganic compounds to a higher plane by deoxidation and union, and from that plane they may fall back, yielding, in the descent, an energy that physicists tell us is equal to that by which it was raised.

In considering the leaves in their relationship to the sun and the whole realm of life upon the earth, it is evident we are face to face with the most potent of vital activities, and are getting at the heart of the forces that move the world.

We might well, with much solemnity, approach the subject that lies before us, for the green leaf, as it stands upon its supporting twig, is a minute laboratory in which a noiseless chemist is constructing compounds that possess a potency peculiarly their own.

With these facts in mind it needs be a very heedless child who will not be impressed with the worth of the wealth of greenness that is met with in the living vegetable fabric that is woven with sunlight to clothe the otherwise barren earth.

From this central thought concerning light relations of plant foliage there are a thousand starting points for study, and time permits of but the briefest mention of a few. Many plants have no green color, but doubtless prosper. These are the parasites, plants that have long ago formed the habit of gaining their nourishment at secondhand, and from those who do their own work of synthesis. The golden-threaded dodder, the sickly-hued mistletoe are of this class. They form no exception in the true sense, for they steal instead of labor for their living.

The mushroom, toadstools, molds, and mildews are other

low forms of plants that live upon organic matter similar to the more exalted flower-bearing parasites.

There are many plants that, while making their own food, are seemingly without green. This is only a seeming, for beneath all the bright color there is an abundance of the chlorophyll, which may be as readily extracted from the showy coleus leaf as from the green grass.

There is a long list of questions that naturally arise in the thoughtful mind as to the behavior of plants in relation to the sunshine. To illustrate this we will go out in imagination into the woods and clearing.

A BIT OF FIELD WORK.

It is possible that a little study like the following may be made. Let me draw the outline of the problem that is to be investigated. Imagine, if you will, you are standing upon a slope of land facing the north, that the sun may not blind your eyes. To the right is a wood lot, with its oak, hickory, chestnut, birch, and other trees, standing neighborly, with arms interlocked, not too closely for comfort, and through the branches the broken shafts of light reach the shrubbery and herbaceous vegetation beneath. There are the alders, huckleberries, and their close of kin, the Virginia creeper, running upon the ground and over the smaller trees in the vicinity of a sleepy rivulet bordered by skunk cabbage and jack-in-the-pulpit. Where it is not quite so marshy the ground view of the woods is delightfully obscured by a luxuriant growth of the cinnamon fern, for it is midsummer.

To the left is a similar piece of young wood lot, not a primeval forest in either instance, and here the wild grape clings to the young maple, and the poison sumach may be lurking in the low land. In front of you, however, lies a strip twenty rods wide, where the woodman's axe has done its destructive work, and the clumps of small growth you see are the sprouts from the maple and other stumps. This is the second season from the time of clearing.

Have you the picture before you? A rectangle of vegetation stretching down to the rivulet that is lost under the direct rays of the summer sun and then on up the slope beyond, all framed in by right lines of forest trees and grateful shadows. If you have located the clearing from my brief outline you are ready to enter in and possess it botanically. If such a piece of land, even though it be but a single acre, is close at hand, you have a treatise upon vegetable ecology and physiology that contains no ends of treasures. Not that it bears any long list of species, but that it does possess the various conditions that, taken in connection with the border land, are more interesting than books, for it is the living volume, that vitalized cyclopædia of facts and the suggestion of principles, that make plant analysis seem tame and useless, save as it may help to catch the convenient handle to hold the subject that is undergoing some delightful transformation.

Let that clearing be your field of study day by day. When the days are long and the heat is intense make notes, and with specimens there gathered retreat into the shade of the wood lot upon either side. Compare the port of the sun-kissed, and it may be sunburned, herb with that of its shaded neighbor of the same species. Both were once alike, but the axe of the woodsman has let in the full sun upon the one, with drying effect upon the soil surroundings. One bears or attempts to bear the burden and heat of the day while the other is nursed in broken sunshine and a moister soil.

The Osmunda in the sun has its fronds strict and upright, the pinnæ uplifted and twisted to lessen the direct exposure. In the shade the habit is that of some other species, with the fronds gracefully curved outward, and the delicate pinnæ so placed as to catch every broken shaft of the sunlight that penetrates the tree tops. The ferns in the open are bleached, while those in the shade are deep green; the former are tough and the latter delicate.

Every plant in the clearing that has survived the ordeal of the exposure is a study of adaptation, the reason for the change

in some instances not being upon the surface; but this only adds to the interest that is centered in the clearing and its surroundings.

This is the newer botany. It is not yet in the books, and, in one sense, never can be. It inheres in the plants themselves, and any attempt to lodge it elsewhere must needs be futile. I trust each teacher of the science of botany may find a field for study in the sense of the clearing above briefly outlined.

It may be more convenient for some student and teacher, and one needs to be both to be the latter, to have a garden patch where plants may be asked various questions. If it is in the line above indicated, a shading total or partial may be easily arranged. For example, a half shade may be provided by placing frames of lath upon stakes. The frames may be made, for a few cents, by nailing ordinary carpenter's laths to cross laths at the ends with a single lath interwoven through the middle. If half shading is desired, let the vacant spaces between the laths be equal to the width of the laths. Under such a shading ordinary plants, like bush beans, lettuce, etc., may be grown, and the variations in time of germination, size of plant, of leaf, time of blooming, size of fruit, longevity, etc., can all be studied with no small amount of interest and profit at a minimum of expense.

Should you like to make a record of the difference in thickness, for example, between the exposed and shaded leaves it can be done by actual measurement, but there is another way not mentioned in the books. Place the bean leaflets, one from the open and one from the shade, upon a slip of clean glass in a photographer's printing frame, and over the two specimens lay a sheet of sensitized paper, and expose them to the sun. When the work is done you will have a print of each, but the thinner one from the shade will have recorded the fact in the darker print. In short, the sun will have made its own registration of its own penetrability.

Nothing that has been named in the way of apparatus is expensive in the ordinary sense. Anyone who can afford to

have a bicycle and keep it in repair is able to follow up the suggestions. That a child of nine years can be interested in this study of plants is certain, for it has been tested by the writer to his entire satisfaction.

RUTGERS COLLEGE,
New Brunswick, N. J.

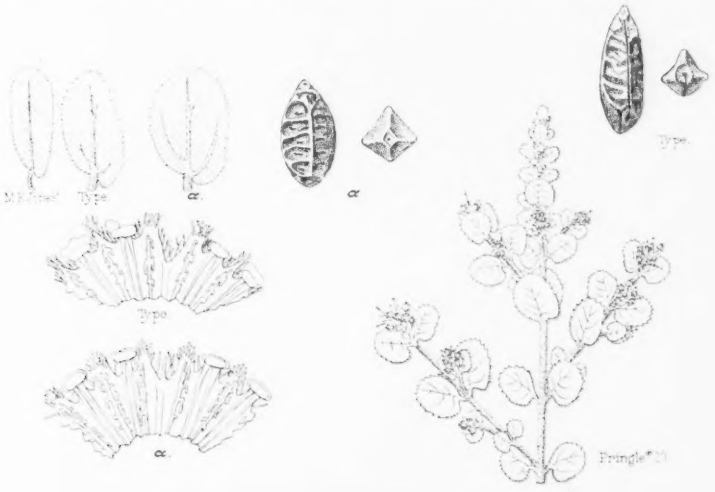
BRIEFER ARTICLES.

NOTES AND NEW SPECIES OF THE GENUS EUPHORBIA.

EUPHORBIA STICTOSPORA Engelm., Mex. Bound. Bot. 187.

The following characters are drawn from the type.

Involucral glands irregular, transverse, the fifth represented by a small lobe or absent; lobes triangular, hairy, the two flanking the deep



EUPHORBIA STICTOSPORA AND VAR. TEXENSIS.[1]

sulcus columnar; appendages three-lobed, rudimentarily one-lobed, crenate, a mere semblance to an appendage, or entirely absent. Seeds pinkish-ashen, elongated-tetragonal, 1.4–1.5^{mm} long, .5^{mm} broad, section more triangular than tetrangular as the ventral angle is obscure, dorsal and lateral angles prominent, rounded, dorsal facets concave, the ven-

[1] In the cuts the portions of plants and the leaves are natural size; the involucres enlarged and diagrammatic, and the seeds enlarged.

tral convex, linea ventralis slight; surface marked with short and irregular interrupted rugae, not pitted.

Type from Kansas, *Fendler* no. 789, co-types New Mexico, Santa Fé, *Fendler* no. 797 and Doña Ana, *Wright* no. 59 (*omnia visa*). The following specimens agree well with type: Colorado, *Marcus E. Jones* no. 786 (1878); Durango, Mexico, *Dr. Edward Palmer* no. 43 (1896), BOT. GAZ. **25**:19, 1898; Chihuahua Mexico, *C. G. Pringle* no. 1076 (1886) and his Coahuila, Mexico, no. 80 (1885).

Var. α. **Texensis**, var. nov.—Similar to the species in general habit, but less hairy and of looser growth, with longer internodes. Lobes of the involucre columnar, pseudolobe a deep sulcus with a long linear pseudogland at its fundus; appendages very narrow, entire, and generally present. Seeds bluish-ashen, strongly tetrangular, 1^{mm} long, $.6^{mm}$ broad, the dorsal facets concave, the ventral plane, all marked by strong, sharp, transverse rugae, that show only a tendency to anastomosis and interruption.

Texas, southern portion, altitude 1600–2000 ft., *A. A. Heller*, nos. 1913, 1918 (1894).

EUPHORBIA COROLLATA L.

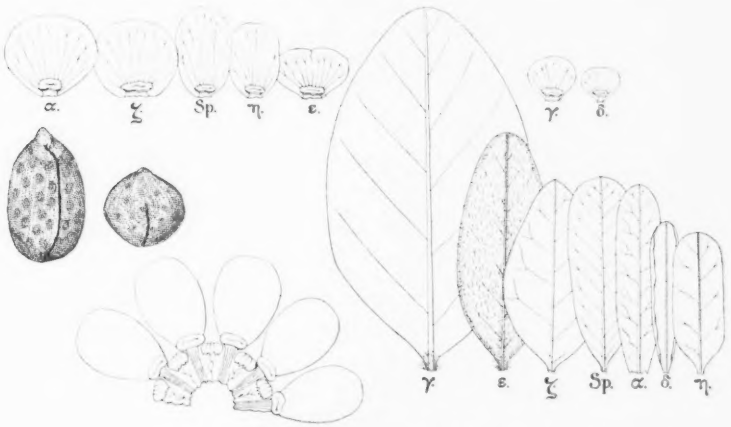
In this species, the most showy of the eastern United States, there is almost unlimited form variation in the general appearance of the plants from different localities, among which those given below may be considered good varieties by strong and reproducing differences in their leaves and glandular appendages. In all the forms and varieties the seeds maintain their full and distinctive characters; they are white-cinereous, ovate-pyriform with a strong nipple-like tip, sub-globular in section, 2.5^{mm} long, 2^{mm} broad, linea dorsalis a rounded evident keel, linea ventralis a dark evident groove, the surface marked with irregular, very shallow, pits.

Sp. COROLLATA L., Amœn. Acad. **3**:122.—Leaves sub-petiolate, spatulate oblong, glabrous, green both sides, 3^{cm} long, 2^{cm} broad. Floral pedicels 4^{mm} long, strict and filiform; appendages oval, plane 3.7^{mm} long, 2.1^{mm} broad.

Var. α. GRANDIFLORA Boiss., DC. Prod. **15**^{2}:67.—Leaves strongly sessile, lanceolate to narrow-lanceolate, glabrous, green both sides, 2.8^{cm} long, 1.4^{cm} broad, less veined than in the species. Floral pedicels 8^{mm} long, strict and filiform, appendages broadly ovate, spreading and drooping, 3.3^{mm} long, 4^{mm} broad.

Var. β. SUBPETIOLATA Boiss., *loc. cit.*— I have not been able to recognize this form.

Var. γ. PANICULATA (Ell.) Boiss., *loc. cit.* (*E. paniculata* Ell., Sk. 2:660.)—Leaves petiolulate, hairy at the petiole only, green above, paler beneath, ovate, 5.5^{cm} long, 3^{cm} broad. Floral pedicels 3^{mm} long, erect and sarcous appendages broadly oval, 1.6^{mm} long, 2^{mm} broad.



EUPHORBIA COROLLATA AND FORMS.

Var. δ. ANGUSTIFOLIA Ell., Sk. 2:659.— Open and widely spreading, openly paniculate-branched above. Leaves sessile, linear, the margins revolute, dark green above, pale beneath, veins not evident, 2–2.3^{cm} long, 3^{mm} broad. Floral pedicels filiform, ascending, 3-7^{mm} long; appendages, ascending, oval 1.4^{mm} long, 1.7^{mm} broad.

Var. ε. **molle**, var. nov.— Hairy throughout, 25^{cm} high; root fusiform: stems erect, denuded below, branches unbelliform, short, with leaves as on the stems: leaves petiolate, green above, pale green or lurid beneath, soft downy both sides but especially beneath, oblong ovate, 3.5^{cm} long, 1.6^{cm} broad, inflorescence solitary at the bifurcations, peduncles sarcous, 1.3–2.5^{cm} long; involucres large; appendages broad and generally partially incised into more or less equal lobes 2.2^{mm} long, 3.1^{mm} broad. Alabama, *Earle & Baker* no. 13 (1897).

Var. ζ. **glauca**, var. nov.— Glabrous, 35–45^{cm} high; stems denuded below, branches unbelliform, nude except a single leaf at the base:

leaves sessile, pale above, glaucous beneath, strongly oval to ovate, few veined, 3^{cm} long, 1.6^{cm} broad or smaller: inflorescence solitary at the bifurcations of the branchlets, peduncles filiform, 8^{mm}–2^{cm} long; appendages drooping, broadly oval, 3.2^{mm} long, 4^{mm} broad. Alabama, *Dr. Vasey*, 1880.

Var. η. JOORII Norton, Rept. Mo. Bot. Gard., **9**: 155. 1898.—Low, 10–14^{cm} high, branching from the base, glabrous or pubescent: leaves ovate or oblong, subpetiolate, 2.2^{cm} long, 8–10^{mm} broad: inflorescence solitary in the bifurcations of the upper branchlets, peduncles filiform, 10–25^{mm} long; appendages elliptical, 3^{mm} long, 2^{mm} broad. Milano, Texas, *Dr. Joor.*

Var. θ. **apocynifolia** (Small). *Euphorbia apocynifolia* Small, Bull. Torr. Club **25**: 467. 1898.—Leaves oblong, tapering at the base into a hairy petiole 3–6^{mm} long; inflorescence open umbelliform, rays ascending, wiry, dichotomous; involucre small, globular-bell shaped, hairy in our specimens, glands roseate like those of vars. *paniculata* and *angustifolia;* appendages 0.7 to 1^{mm} long, 0.9 to 1.2^{mm} broad, shaped like those of var. *paniculata.*

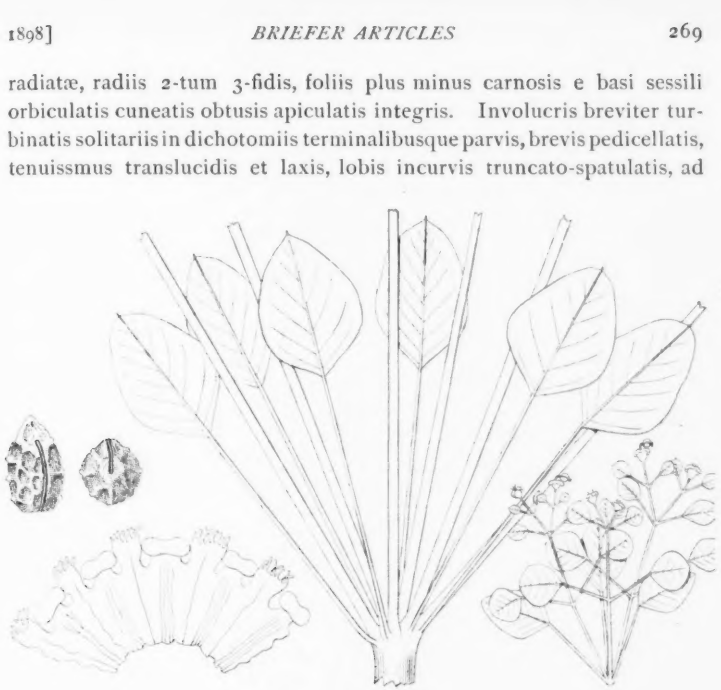
This form manifestly connects var. *angustifolia*, through Pollard's Mississippi 1289 (1896), with var. *paniculata;* it has no characters sufficiently prominent to consider it a species, while its seeds are not distinguished from those of *E. corollata.* Florida, Nash no. 2567 (1895), distributed as *E. corollata paniculata.*

Euphorbia Nelsonii, sp. nov.—Fruticosa, glabra, longe et corymbosæ ramosa, ramis teretis, internodiis longis, cortex maculatis, maculæ oblongis roseus. Foliis inferioris fasciculatis, petioliis longis filamentosis, pagina tenuis ovato-cuneatis, obtusis, apiculatis, foliis floralibus oppositis, orbiculatis petiolis limbum aequantis. Involucriis terminalibus corymbosis, pedunculatis, campanulatis glabris, lobis latis truncatis irregulariter 6–8-fimbriatis, glandulis 5, transversis oblongis integris, appendicibus minutis vel nullus. Stylis longis revoluto-circinalis. Capsulæ luridæ profunde tri-sulcatæ, semine sub-globosis pallide-fuscis, scrobiculatis, linea media nigra geminatis, rugæ anastomosantis tuberculatis 2^{mm} long, 1.9^{mm} lat.

Ad Insula Maria Madre, Insulæ Tres Mariæ, Mexici, coll. E. W. Nelson m. Maius 1897, num. 4284. Internodii 10–12^{cm} long., petiolo 3–4.5^{cm}, pagina 1.5–2^{cm} long, 1.3–1.5^{cm} lat., prox. *E. petiolariæ.*

Euphorbia Hellerii, sp. nov.—Glabra, caulibus pluries ascendentibus laxis foliatis, foliis alternatis spathulatis petiolulatis obtusis, umbellæ 3-

radiatæ, radiis 2-tum 3-fidis, foliis plus minus carnosis e basi sessili orbiculatis cuneatis obtusis apiculatis integris. Involucris breviter turbinatis solitariis in dichotomiis terminalibusque parvis, brevis pedicellatis, tenuissmus translucidis et laxis, lobis incurvis truncato-spatulatis, ad



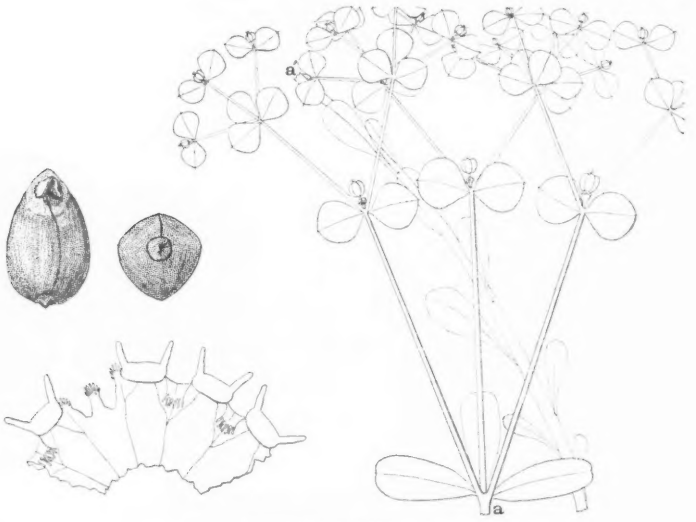
EUPHORBIA NELSONII.

apice fimbriatis, ad sinus minor et erectis, glandulis 4, bicornatis quintus, pseudolobis columnaro-fimbriatis in sinus involucris substitutere. Stylis recurviis as apice in lobis claveo-stigmatosis bifurcatis. Capsulæ profunde trisulcatæ coccis dorso-rotundato laevis. Semine laevis cinereus vel virido-cinereus, ovato in sectio triangulo-subsphaerico 1.7^{mm} long, 1.2^{mm} lat., linea dorsalis notatis, caruncula conica tenuissima depressa.

Ad Corpus Christi in ditione Texas. A. A. Heller, m. Martius, 1894, num. 1509. Folius ramulosis, 1.7^{cm} long., 6^{mm} lat., fol. radiis 6–8^{mm} long. et lat. Habitus *E. Peplæ*, sed. prox. *E. multicaulæ*. Symboli in herb. C. F. M., et herb. U. S. Nat. Mus., num. 213 et 921.

EUPHORBIA HIRSUTA (Torr.) Wiegand.—In raising this form of *E. Preslii* Guss.? to a species in BOT. GAZ. **24**: 49–52. *pl. 3*. (Britt. & Brown Illustr. Flora N. A. **3**: 518, *fig. 2341a*), Mr. K. M. Wiegand resurrects an old specific name, and adds one more synonym to the unfortunate American relative of that puzzling triune (?) *hypericifolia-*

Preslii-nutans, the types of which have never been studied closely by any American. *E. hirsuta* Kit. ex Boiss. in DC. Prod. 15²:-116; and *E. hirsuta* Schur., Verh. Sieb. Ver. Nat. 4:66 are plants of a section far removed from Dr. Torrey's *E. hypericifolia* var. *hirsuta* which,



EUPHORBIA HELLERII.

for the present, at least, it is better to let alone. Professor Greene noting this synonymizing of Mr. Wiegand (Pitt. 3:207) adds one more name for good measure, *E. Rafinesquii*, and all because the good Linné did not mention the fact that his type of *E. hypericifolia* was hairy!

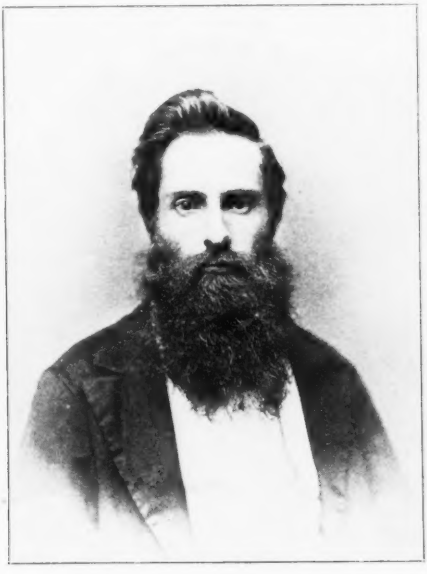
EUPHORBIA BRASILIENSIS Lam.—In making up his Durango sets for distribution, Dr. Edward Palmer mixes this species with his *E. Preslii* Guss.? under no. 894. The black seeded specimens are *E. Preslii*, the cinereous ones *E. Brasiliensis*.—CHARLES F. MILLSPAUGH, *Field Columbian Museum, Chicago.*

JOSEPH F. JOOR.[1]

THE south has always been a land of peculiar botanical interest. Its vegetation, bordering on the tropical, many years ago attracted the

[1] While working with Dr. Joor's plants, purchased by the Missouri Botanical

attention of the pioneers of American botany. Since those times, except for the work of a few, the south has been much neglected. Scientific and other educational work was broken into by the war, and since then there has been little to excite botanical activity, except



Joseph F. Joor

natural love for the work, and the inspiration of the rich flora. It was in this land, and under these conditions, that the subject of this sketch spent his active, but unassuming life as a botanist and collector.

Joseph F. Joor was born on the Comite river in East Baton Rouge parish, Louisiana, on August 9, 1848. His parents removed to Illinois when he was quite young, where, as a boy, his botanical tastes were

Garden, I collected all the notes regarding him and his work that could be found with the specimens. Thinking it would be of some value, I have since completed this sketch of his life by the aid of Mrs. Joor and a number of botanists and other scientific men who knew him. To these I am indebted for the facts presented.

developed. Each holiday and Saturday when free from school duties he might be found engaged in his favorite study, wandering over the Illinois prairies. His Latin teacher, one of that honored class of botanist physicians to whom we owe most of the early botanical work of this country, assisted him much in his botanical recreations.

In 1865 his parents returned to Baton Rouge, where he continued his studies under the tutorship of Professor McGruder, but soon afterward left school to enter a drug store in Baton Rouge, where he began to read medicine, and soon surprised his preceptor, Dr. Day, by the rapidity with which he acquired knowledge.

He was soon a resident student in the Charity Hospital of New Orleans, and in the New Orleans School of Medicine, graduating in 1870, when he was only a little over twenty-one years old, and receiving an offer of an assistant professorship in his alma mater. Dr. Joor's duties were to begin the following autumn, but the disastrous end of a law suit, which closely concerned the college, resulted in closing its doors forever. Through these years of hard study the young physician by no means lost his interest in botany, but kept adding collections from the southern flora to those made in Illinois.

In October 1870, Dr. Joor obtained the position of Assistant Quarantine Surgeon at Ship Island Station. Here and at other places along the Gulf coast the rich flora so attracted him that he sometimes even endangered his life to obtain desirable plants. His health, broken down by study, was much restored by this outdoor life, and he soon entered into private practice in Thibodeaux, Louisiana.

In 1873 we find our physician-botanist practicing his profession on the Texas prairies in the midst of the rich flora of eastern Texas, first at Harrisburg and then at Birdston. Here, when Nealley was collecting grasses in Texas, they met and were together at every opportunity in their work. But the life of a practicing physician on the plains was too much for his naturally weak constitution, and for years he was hindered by severe illness from carrying on his work.

In preparation for the World's Industrial and Cotton Centennial Exposition at New Orleans in 1884–5, Dr. Joor was appointed Assistant Commissioner for Texas to prepare an exhibit of woods and other plants from that state. At the close of the Exposition, where he had charge of the collection he had made, Dr. Joor prepared the woods for a permanent exhibit at the state capital, where they now are. At the same time a smaller collection was made for the Geo-

logical and Scientific Association at Houston, of which he was a member. In the preparation of the New Orleans exhibit he traveled much in Texas and Louisiana, adding at the same time to his private collections and much improving his health. At the Exposition he met a number of botanists whom he had known before only by correspondence, and was especially delighted to meet Dr. Vasey, who went in search of him. They both had a common interest in the southern grasses then, and the inspiration of this meeting renewed Dr. Joor's activity in that direction. It is said that at this time he probably had a better field knowledge of Mississippi, Louisiana, and Texas, than anyone else.

The next year Dr. Joor was appointed Commissioner of Forestry in his native state, but soon accepted a position in Tulane University at New Orleans, and in October 1888, assumed charge of the Museum there as Assistant Curator. He spent much time arranging and enlarging the neglected herbarium of the institution, which already contained the collections of Hale, Riddell, and Carpenter. Dr. Joor increased it much by exchanges and additions from his own herbarium.

Three months later he was elected Professor of Botany. As there were no classes he never taught in the University, but is said to have taught some botanical classes in the New Orleans high school. He held the position at Tulane until death ended his labors, July 25, 1892, at the age of forty-four.

Though Dr. Joor was naturally retiring, he inspired in those who knew him that regard for himself and his favorite study which the true student of nature always does. He was a close observer and an intensely enthusiastic collector, but had no means of describing the new things he discovered.

Very little from his pen has ever been published. A single paper, "Forests and Climate," in "Papers read before the New Orleans Academy of Science," 1: 72–80, 1887, is the only one I have seen. He is said to have published an article in the *Medical Record* concerning a supposed medicinal tree in Louisiana with which he had experimented; and also one in the Texas *Farm and Ranch* discussing a plant being sold in Texas as the tea plant. Reports of his work in connection with the Exposition were prepared, but I cannot find that they were ever published. He long contemplated publishing a flora of Mississippi, Louisiana, and Texas, the lists of plants having been

prepared in manuscript, but his enthusiasm was far greater than his strength and resources. With very few facilities for successful botanical work, and a weak physical constitution, he was compelled in discouragement to give up this large undertaking.

Dr. Joor's herbarium, which is the main record of his work, is not large, but is rich in specimens from the region where his life was spent. It is especially valuable because from that part of the south not well known to botanists, and covered by none of our manuals. A part of his collections, as before stated, were incorporated into the herbarium of Tulane University when he was connected with it. The rest were purchased from Mrs. Joor in 1897 by the Missouri Botanical Garden.

Most of the collections were made about New Orleans and Baton Rouge, Galveston bay, and other parts of Harris county, Texas, where he lived, and in Navarro and adjoining counties when he lived at Birdston, with occasional excursions into other parts of the south. In the last year of his life he spent several weeks along the Mississippi gulf coast, making large collections and preparing a list of the plants of that region. His herbarium was also enriched by the collections of botanical friends and others in whom his own devotion had inspired an interest in plants. Dr. Joor was a correspondent of Vasey, Engelmann, Mohr, Chapman, and other botanists of this country. He was the first collector of several new southern plants. Though he described none himself, his herbarium notes show that some afterward described by others were recognized by him as new. Among others of which he was the first discoverer, *Panicum Joorii* Vasey, *Carex Joorii* Bailey, *Barbula Jooriana* Müller, and *Euphorbia corollata Joorii* Norton, bear his name.—J. B. S. NORTON, *Missouri Botanical Garden.*

FOUR GENERATIONS OF BOTANISTS IN ONE FAMILY.

IT is seldom that the names of more than one generation of a family appear in connection with any one branch of scientific research. The history of science appears to show that genius or ability is not handed down, at least to any remarkable degree, in most families from one generation to another. As a general thing the pursuit of science is not lucrative enough to keep more than one generation from becoming paupers, and even where there is some wealth and ability the suc-

ceeding generation, as a rule, is not fortunate enough to inherit the characteristic traits necessary to follow the calling of its predecessors. However, exceptions occur where similar traits have shown themselves in a decided manner for more than one generation in a single family. Among these may be mentioned the Darwin and Schimper families, and the DeCandolle family offers one of the most striking illustrations. Indeed, the history of science scarcely shows another name representing so many illustrious and able workers in one family, devoting themselves to one branch of science.

It was my fortune to stop a few days at Geneva during the summer of 1896, where I had the pleasure of spending some delightful and profitable hours with the DeCandolle family. The family is one of the oldest as well as one of the most highly esteemed in Geneva, having fled from Provençe to Geneva in the year 1591, where they have been held in esteem for many years as public spirited and highly accomplished citizens.

Augustin-Pyrame De Candolle is known to botanists as a rare genius, who accomplished a prodigious amount of work, and who left behind him a name second only to that of Linnæus. The charming traits which this renowned botanist is said to have possessed are known only to the younger generation of botanists through his memoirs. However, these traits are quite readily realized by those who have met the present members of the family.

It is not my intention to mention the various works of the elder DeCandolle or of those of his son Alphonse, as such an enumeration would be quite unnecessary.

The name of Casimir DeCandolle, the son of Alphonse, has also long been familiar to American botanists, but the name of his youngest son Augustin, who is now devoting his attention to botany, is probably not familiar on this side of the Atlantic.

M. Augustin DeCandolle, who now represents the fourth botanical generation in this family, and who bears the name of his illustrious great-grandfather, is about 27 or 28 years old, and was born and educated in England, which was formerly the home of his mother. He studied a number of years at Rugby, and after finishing his course there he spent a year at Heidelberg, going from there to the University of Leipzig, where he took a course in jurisprudence.

Although he did not take the university course in botany while at Leipzig, his interest in the subject was quite marked, and his oppor-

tunities and associations were always such that he naturally acquired a considerable knowledge of this subject.

Since his return from Leipzig he has spent most of his time assisting his father at the herbarium in Geneva, besides carrying on some original work along histological lines, some of the results of which have already appeared as abstracts in the *Archives des sciences physiques et naturelles*, of Geneva.

M. Augustin DeCandolle occupies a villa pleasantly situated in the suburbs of Geneva, which also includes about sixty acres of land; while that of his father is on the shores of Lake Geneva, near Versoix, and about ten or twenty minutes' ride from Geneva. Both residences are provided with greenhouses and gardens.

One of the most interesting features connected with Geneva for a botanist, however, is the herbarium and library which is contained in the old DeCandolle homestead at Cour de St. Pierre, and which was formerly occupied by the elder DeCandolle. The building is situated in the older parts of the city, and is not far from the University and Botanical Gardens, which were laid out by the elder DeCandolle; and here is to be seen a very good life-size statue of its founder. The herbarium and library and working rooms occupy the upper stories, and, with the exception of the large number of cases which have been added, the rooms are just as they were when occupied for residence by the elder DeCandolle.

Here one can not only find interest in the large herbarium, but he will find the rarest and most valuable collection of old botanical books in existence. The library contains many other interesting features, such as photographs and autographs of nearly all the botanists the DeCandolles have known. It contains also all the prominent periodicals and recent botanical literature of various countries up to date. The expense of maintaining the herbarium and library is met entirely by the DeCandolles. It is the desire of M. Casimir DeCandolle to make the library as complete as possible, and he is always pleased to receive contributions from American botanists.

New plants are continually being added to the herbarium, which are placed in the general collection. The special collection relating to the *Prodromus* is kept by itself. As this work is of considerable consequence, an experienced curator is employed to look after it, together with the many details connected with the ever increasing library.

It is here that Casimir DeCandolle and his son Augustin do their botanical work, and although the library and collection is a private one, the keeping up of which involves considerable expense, they are always willing to have other botanists avail themselves of any appointments which the large collection offers.

M. Casimir DeCandolle speaks English fluently, and his intense interest in all matters pertaining to botany, and his characteristic modesty, together with his exceedingly broad and comprehensive knowledge, afford a striking contrast to what one often meets in other parts of the continent. As in the case of the other DeCandolles, he has contributed to every department of botany. We find the name associated not only with an enormous amount of systematic investigation, but also with the physiology, histology, morphology and history of plants.—G. E. STONE, *Mass. Agric. College, Amherst.*

SOME RESULTS FROM THE STUDY OF ALLIUM.

DURING the summer of 1897, at the University of Chicago, I began a morphological investigation of certain species of Allium, being attracted chiefly by the often quoted polyembryony of *A. tricoccum* Ait. My results in the case of this species indicate that if polyembryony occurs at all, it is very rare. Besides *A. tricoccum*, I examined more or less thoroughly *A. cernuum* Roth, and *A. Canadense* Kalm, with the same general result. Seventy-five embryo-sacs of *A. tricoccum* were examined at the stage in which both egg apparatus and antipodal cells ought to have been found. The egg apparatus was found in seventy of them, and the appearance of the sacs in which it was not found would indicate that it had been lost by accident, as all other structures were normal. Of the seventy-five sacs, only sixteen contained antipodal cells, and these antipodal cells were usually small, and it was seldom that more than one or two could be found. In one sac there were three antipodal cells in a row, but in other cases where three were found they were crowded together irregularly. Wherever antipodal cells were found, they had a shriveled, dead appearance, and stained with difficulty or not at all. Twenty-six embryos were examined, all of which had developed from the egg cell. No trace of antipodal cells could be found in any sac in which the embryo had begun to develop.

The results from *A. cernuum* were nearly the same as for *A. tricoccum*. Ninety-five embryo sacs were examined in the eight-celled stage. The egg apparatus was found in all of them, while antipodal cells were found in only twenty-nine; and, as in *A. tricoccum*, these were invariably small, and apparently about to disappear. It was seldom that more than one or two could be found. Of the ninety-five specimens, thirty were collected on or after August 16, and no trace of antipodal cells could be found in any of these. Fifteen embryos were examined, all of which were normal in position and number. No antipodal cells were present in any sacs in which the embryo had begun to develop.

My collection of *A. Canadense* was made from a patch covering about half an acre, at West Pullman, Illinois. In nearly every specimen the nucellus had died long before the stage when fertilization might have taken place; and later in the season it was found that only six embryos had developed from the whole patch in which there had been thousands of blossoms. All of these embryos, however, were in the normal position.

Since in *A. tricoccum* only about 21 per cent., and in *A. cernuum* about 30 per cent. of the sacs examined contained antipodal cells, and these cells in all cases were small and not found at all except in the earlier stages, the development of embryos by antipodal cells in these species seems very doubtful.—CLARENCE J. ELMORE, *Crete, Nebraska.*

OPEN LETTERS.

THE AMERICAN BOTANIST.

UNDER THE TITLE of "The American Botanist, vol. I, no. 1" a four-page octavo leaflet was issued September 15, 1896. While no place of publication is stated, the editor of this newly launched periodical gives his temporary address as the Gray Herbarium, Cambridge, Mass. It is true that he has received such facilities of reference to books and specimens as are usually accorded to visiting botanists, but to prevent a possible misunderstanding, it seems necessary to state that his publication has no official connection whatever with this establishment.—B. L. ROBINSON, *Curator of Gray Herbarium.*

ESCHSCHOLTZIA MEXICANA-PARVULA.

ESCHSCHOLTZIA finds its extreme eastern limit in the Organ mountains of New Mexico, and the adjacent region about El Paso. The pretty little species there found, which I have had occasion to study in connection with its bee-visitors, is commonly known as *E. Mexicana* Greene, Bull. Cal. Ac. Sci. 1 : 69. 1885. I want to know why it is not to be designated *E. parvula* (A. Gray), for it is assuredly the *E. Douglasii* var. *parvula* Gray, Plantæ Wrightianæ 2 : 10. 1853. The few words of description given by Gray, with the locality, readily identify the plant. There is no other *parvula* of prior date. Is it not just a little absurd to refuse to recognize a name for a species, because first applied in a varietal sense? Such a course seems hardly to accord with a Darwinian conception of species, nor is it supported by the codes of nomenclature.

Another principle which is generally recognized, in zoology at any rate, is that the specific name must be at least as old as the names applied to varieties of the species. Thus it will sometimes happen that the type form of a species is by no means the commonest form; it may be quite a rare variety. On Darwinian grounds I see no objection to this, as the oldest (and therefore true) type of a variable species is hard to ascertain, and the probabilities are perhaps against its being the most common.

It follows from the above that *Philibertella Hartwegii* (Vail, 1897) *heterophylla* (Engelm., 1856–7), as given in Bull. Torrey Bot. Club 24 : 308. 1897, will not do. The species must stand as *Philibertella heterophylla* (Engelm.), and the *Hartwegii* form, if properly belonging to the same species, can be treated as a variety.—T. D. A. COCKERELL, *Mesilla Park, N. M.*

CURRENT LITERATURE.

BOOK REVIEWS.

Plant Life.[1]

THIS is the suggestive title of a new text-book of elementary botany, for its standpoint is function rather than structure. There can be no question as to the usefulness of the book, and as to its value as a contribution to our botanical texts. The style is clear and simple; the presentation is very logical; and many things are said which needed to be said. Teachers apart from the universities are in constant danger of holding to abandoned views, and a book is needed now and then to bring a rapidly developing subject up to date.

The book before us has done this service admirably, and its four parts present a clear elementary statement of present views of the vegetative body, physiology, reproduction, and ecology. This division of the subject enables the author to present these great subjects continuously, without breaking them up into fragments, and the comparative view thus becomes very prominent.

While all the parts are fresh, those which deal with physiology and ecology are especially noteworthy. The facts of physiology are accumulating and the views are shifting so rapidly that an elementary statement was needed, and it would be hard to find a completer outline in forty-six pages than is found in this book. The ecological view of plants is new in elementary instruction, to which it is especially adapted, and it is to be hoped that this modest beginning is but a promise of the time when it will dominate all of our texts for elementary instruction.

Only less commendable is the comparative and separate presentation of vegetative and sexual reproduction, which are in great danger of being confused in elementary instruction. In this part it was necessary to adopt some consistent terminology. How successful the author's suggestions will prove remains to be seen; they certainly could not be simpler.

Five appendices give information as to laboratory study, collecting and preserving material, apparatus and reagents, reference books, and an outline of classification.

[1] BARNES, CHARLES REID.—Plant life, considered with special reference to form and function. Pp. x + 428, with frontispiece and 415 figures. New York: Henry Holt & Co. $1.12.

However admirable the book may be as a general statement of the essential facts of botany, it will suggest criticisms from the standpoint of teaching. The most important of these the author has forestalled by stating that "this is not a book to be recited." In the text the same plant is discussed several times under different headings, a method that would not commend itself either for recitation or for laboratory work, but in the directions for laboratory work all the essential structures are called for while each plant is in hand. It is very evident, therefore, that the intelligent teacher is to use the book for assigned readings suitable to the material under examination in the laboratory and supplementary to it. It is hard for some teachers to get away from the idea of the recitation of consecutive pages.

Another criticism will be that the book is better designed for schools as they ought to be, than for schools as they are. The author practically confesses that he is writing for a somewhat ideal condition, and probably he is; certainly for a condition less realized in the east than in the west, where elementary instruction in science is so much further advanced. However, it is a matter of doubt to the reviewer whether any but the exceptional secondary schools will ever be able to do completely such morphological work as this book calls for; and also whether it is the most desirable work for them, handicapped as they are by lack of equipment, time, and age. First impressions must be correct, but it may not be necessary to include at first recondite things even if they are essential. There cannot be too much of ecology and physiology in elementary work, but it has seemed to the reviewer that recondite morphological structures are in danger of being pressed too far with elementary students.—J. M. C.

The Illustrated Flora.[2]

With the appearance of the third volume this important work is complete, and the authors should be congratulated upon its prompt publication, the first volume having appeared in 1896. Volume one was reviewed in the Gazette **22**: 269. 1896, volume two in **24**: 120. 1897, and little need be added in reference to the present volume, which contains the great sympetalous families. Use of the work has proved its adaptation to the needs of those who wish to determine plants, and it should certainly find a place in the library of all interested in taxonomy. When it is remembered that 4162 species are described and illustrated, representing 177 families and 1103 genera, it is surprising that the illustrations are so well done. The present volume, in an appendix, adds the descriptions and illustrations of eighty-one

[2] Britton, Nathaniel Lord, and Brown, Addison.—An illustrated flora of the Northern United States, Canada and the British Possessions. In three volumes. Vol. III. Apocynaceæ to Compositæ. 8vo. pp. xiv + 588, fully illustrated. New York: Charles Scribner's Sons. $3.00.

species, mostly western, which are new determinations or new discoveries made while the work was going through the press.

Certain special features of the volume deserve mention, such as a general key to the orders and families, a glossary of special terms, a general index of Latin names with very full synonymy, and an English index including popular plant names. This last is the completest compilation of American plant names hitherto published, containing about 10,000 names, and over 12,000 references to the illustrations.

It will be remembered that the territory covered by the work extends from Newfoundland to the parallel of the southern boundary of Virginia, and from the Atlantic ocean westward to the 102d meridian, a territory extending somewhat further to the north and west than that covered by the sixth edition of Gray's *Manual*. A comparison of the number of species of spermatophytes recognized by the two is interesting, and is shown in the following table:

	Gymnos.	Monocot	Archichlam.	Sympet.	Total
Manual	22	785	1226	1022	3055
Ill. Flora	27	1058	1601	1361	4048

This difference of a thousand species is explained partly by the more extensive range of the *Illustrated Flora*, but is most largely due to a different conception of species. The two works may be considered as complementary, and both are very useful.— J. M. C.

Report of Missouri Botanical Garden.

THE ninth annual report of this very active establishment was issued last March, and continues its valuable contributions, chiefly to taxonomy. Thompson's paper on Lemnaceæ has already been noticed in the GAZETTE (24: 440. 1897). The other papers are as follows:

1. GLATFELTER, N. M.: "Notes on *Salix longipes* Shuttlw. and its relations to *S. nigra* Marsh.," in which the author attempts to prove their title to be considered distinct species.

2. IRISH, H. C.: "A revision of the genus Capsicum with especial reference to garden varieties." This is really the completion of work undertaken by the late Dr. E. L. Sturtevant, for which he collected a great amount of material and literature, all of which with his drawings, notes, etc., were given to the Missouri Botanical Garden in 1892. The work was further prosecuted by F. W. Dewart and then by J. G. Smith, and finally, in 1896, was undertaken by Mr. Irish. The last revision of the genus was that of Dunal in 1852, in which fifty species were recognized; and but three new species have

been described since. The *Index Kewensis* cites about ninety specific names, and recognizes fifty-four as good. Students of the genus have long suspected that most of the so-called species are but forms of a few exceedingly variable species, and Mr. Irish has reached the conclusion that there are but two species, *C. annuum* and *C. frutescens*, the one annual or biennial, the other perennial. He has preserved the well-fixed types of cultivated forms as botanical varieties. Twenty-one plates fully illustrate the paper, which is a remarkable piece of patient work in a very perplexing subject.

3. HITCHCOCK, ALBERT S.: "List of cryptogams collected in the Bahamas, Jamaica, and Grand Cayman." These collections were made the winter of 1890–1, and a list of the spermatophytes and pteridophytes was published in the fourth annual report of the Garden. The list of cryptogams contains seventy-three species, some of them new, and all determined by specialists in the several groups.

4. ROSE, J. N.: "*Agave Washingtonensis* and other agaves flowering in the Washington Botanic Garden in 1897." The large collection of agaves in the Botanic Garden at Washington has never been critically studied, and promises to contain several undescribed species, one of which Mr. Rose and J. G. Baker describe and figure in the present paper.

5. THOMPSON, CHARLES HENRY: "The species of Cacti commonly cultivated under the generic name Anhalonium." Mr. Thompson has done good service in supplying full notes and excellent photographs of living plants of these disputed forms. He regards the group as consisting of two genera, *Ariocarpus* Scheidw. (*Anhalonium* Lem.) and *Lophophora* Coulter.

The report closes with a series of "Notes and observations" as follows: "The *Epidendrum venosum* of Florida," by W. Trelease, with full description and two plates; "Miscellaneous observations on Yucca," by W. Trelease, with four plates; "The Missouri dogbanes," by W. Trelease, with two plates; "A coloring matter found in some Borraginaceæ," by J. B. S. Norton; "Notes on some plants chiefly from the southern United States," by J. B. S. Norton, with five plates and three new species; "A new disease of cultivated palms," by W. Trelease; and "*Parmelia molliuscula*," by Henry Willey.— J. M. C.

The flora of Africa.

THE activity, not to say rivalry, displayed by taxonomists of Belgium, England, France, and Germany in the publication of the African flora is remarkable. The book before us[3] is a Belgian contribution, the first part

[3] DURAND, TH. et SCHINZ, HANS: Conspectus Floræ Africæ. Vol. I, part 2. Dicotyledons (Ranunculaceæ–Frankeniaceæ). 8vo. pp. 268. Berlin: R. Friedländer and Sohn. Paris: Paul Klincksieck. *fr.* 12.50.

of which (Vol. V), containing monocotyledons and gymnosperms, appeared in 1895, and was noticed briefly in the GAZETTE (**20**: 278. 1895). The long delay in the appearance of a second part was due to various reasons, but has had its advantages in permitting the authors to include the results of the recent extraordinary activity in the study of the African flora. As the present volume has been in process of publication since 1895, the authors have wisely indicated the date of publication of the different parts of the volume, extending from October 1895 to April 1898. The work is not descriptive, but is simply a catalogue of described species, with bibliographical citations, synonymy, distribution, and occasional critical notes. The work will be complete in six volumes of about 500 pages each.— J. M. C.

A new botanical text.

A RECENT French work,[4] which is a valuable contribution to botanical texts, is that of Professor L. Courchet, of the School of Pharmacy at Montpellier. The author purposes only to write a treatise for the use of students in the professional schools of France, which seem to demand mainly work with spermatophytes. The first part is devoted to the general morphology (in the old sense) of spermatophytes, and a second much larger part to a systematic description of the natural families. The most striking feature is the unusual space given to the dicotyledons, a proportionate space unequaled in any English text we have seen. Thallophytes are given 130 pages of amply illustrated text, to bryophytes are allotted 12, pteridophytes are presented in 44 pages, while spermatophytes occupy 1540 pages, 1356 of which are devoted to the dicotyledons. Such a distribution of space in a general text must make the plant kingdom seem like a huge mushroom to the observing student. The text throughout is accompanied by good illustrations, and the keys and summaries which accompany each family are worked out with great completeness.— J. G. COULTER.

The study of lichens.

THIS group has few special students in America, and certainly receives but little attention from amateurs. As lichens are found almost everywhere, they would speedily attract collectors and students if some suitable book were provided as an introduction. Such a book Dr. Schneider[5] has prepared, stating that it "is especially written and arranged for the use of amateurs in the study of lichens." Just how useful it will prove remains to be seen, but we wish it all the success that its purpose deserves. The author's general

[4] COURCHET, L.— Traité de Botanique. 2 vols. 8 vo. pp. viii + 1320. *figs. 514.* Paris: J. B. Bailliere et fils. 1897. *fr.* 12.

[5] SCHNEIDER, ALBERT.— A guide to the study of lichens. Small 8vo. pp. xii + 234, *pl. 11.* Boston: Bradlee Whidden. 1898.

views in reference to lichens were fully stated in a review of his *Text-book of general lichenology*, published in the GAZETTE (**25** : 284. 1898), and there is no need to repeat them here. On account of existing difficulties of nomenclature, the author omits all citation of authorities, stating that "the names given are well authenticated, so that those who have the desire and the opportunity may enter into the consideration of the synonymy and the nomenclature controversy." A selection is made of the more common forms of lichens occurring in the United States, those with which the collector is most likely to come in contact.

The first part of the book discusses lichens in general, under such headings as "The history of lichenology," "The use of lichens," "What are lichens," "The morphology and physiology of lichens," "The occurrence and distribution of lichens," and "Lichens and the naturalist," under which last title directions for collection, study, and preservation are given.

The second part is devoted to the systematic presentation of the group, an artificial key being provided for the more important genera, and a natural key for the families. A check list of lichens occurring in the United States is also given, useful to those who wish to make exchanges or to get some knowledge of the extent of the group and its various genera.—J. M. C.

MINOR NOTICES.

A NEAT MANUAL of seventy-nine pages and half a hundred cuts has been recently issued by W. Edgar Taylor, professor of biology in the Louisiana Industrial Institute, for the use of his classes. The printing was done and many of the drawings were made by pupils of the school, and the result is creditable. It is intended solely to meet local needs, including lessened cost to the pupils, and, although in book form, is of the nature of extended laboratory notes. It goes over the ground of the cryptogamous plants and unicellular animals, with an introduction on the cell.—J. C. A.

THE SECOND PART of the Welwitsch Catalogue of African plants, by W. P. Hiern, and published by the British Museum, has just appeared, including Combretaceæ to Rubiaceæ. The occasion of the publication was stated in the review of the first part published in the GAZETTE (**23** : 210. 1897). Although the date of the collections is 1853–1861, the region has been so little explored that the book is full of new material. In the present part the great family Rubiaceæ is of much interest, three new genera (*Pentacarpæa*, *Justenia*, and *Chalazocarpus*) and fifty-eight new species being described. The only other new genus is *Campylochiton* (Combretaceæ).—J. M. C.

A LITTLE BOOK before us by Clarence Moores Weed, entitled *Seed travellers*, has been prepared as a supplementary reader in connection with nature

study in the schools.[6] The author recommends "that this little book be used in connection with observations upon the specimens treated of; that the studies be read by the individual pupils, either with the objects in hand or for the purpose of inciting them to search for the specimens. . . . . It may then be advisable, after most of parts have been read, to review the whole subject by having the pupils begin at the first of the book and read it through consecutively, with or without studying the objects again." With this purpose in mind the author has described the way in which the wind and birds act as distributors of seed. He has, also, very briefly shown the method of seed distribution by spines and hooks. The book is attractively written and is accurate as to its facts. The illustrations, as a whole, are fairly good, but are very unequal in quality. The style is not always simple, but the book generally will be quite intelligible to children. This is an addition to the list of available nature readers, and as such is to be warmly welcomed.—C. R. B.

THE GENUS Cyclamen has been studied by Dr. Friedrich Hildebrand, whose results have recently been published.[7] The necessity of associating ecologic and taxonomic studies is becoming more and more apparent, and the monograph before us is a worthy type of the most effective method of investigating plant groups. The genus was very favorable for such study, containlng only thirteen species, and all of them accessible, being restricted to the Mediterranean region. In the disentanglement of herbarium material and literature, the author has found sufficient names already provided, except in the case of *C. alpinum*. It is the so-called "biological" part, however, that is of chief interest, and that deserves especial commendation to our taxonomists. Any adequate review would mean a synopsis of the work.—J. M. C.

THE SERIES of classics in various exact sciences, which are being published by Engelmann, has been enriched by the addition of no. 95, which includes four papers by Ernst von Brücke.[8] These papers are as follows: I, Bluten des Rebstockes; II, Bewegungen der Mimosa pudica (1848); III, Elementarorganismen (1861); IV, Brennhaare von Urtica. All these papers are interesting, especially to show how at an early period in the study of plant physiology exact and careful experimentation led to well-founded and stable results. Probably the best known of the four papers is the second one, which Sachs calls a model of accurate experimentation and clear presentation. Brücke was trained for medicine, and in 1843 became an assistant in the Museum of Comparative Anatomy through his relations with Johannes Müller.

[6] WEED, CLARENCE MOORES.—Seed travellers: study of methods of distribution of various common seeds. 12mo. pp. vii + 53, *figs. 36*. Boston: Ginn & Co. 1898.

[7] HILDEBRAND, DR. FRIEDRICH.—Die Gattung *Cyclamen* L., eine systematische und biologische Monographie. pp. 190. *pl. 6*. Jena: Gustav Fischer. 1898. *M.* 8.

[8] Ostwald's Klassiker der exacten Wissenschaften no. 95. Physiologische Abhandlungen. 12mo. pp. 86. Leipzig: Wilhelm Engelmann. 1898. *M.* 1.40.

Shortly he turned his attention to physiology, and was soon made associate professor at Königsberg. In 1849 he was called to the professorship of physiology in Vienna. Here he remained to his seventieth year as teacher and indefatigable investigator, surrounded by numerous pupils, who were inspired by his vigor and enthusiam. In 1889 he retired from active work, and died in 1892. His industry and success are somewhat indicated by the long list of scientific papers — one hundred and thirty — which he published.—C. R. B.

NOTES FOR STUDENTS.

A THIRD ARTICLE, by the colonial botanist, F. M. Bailey, enumerating the fresh-water algæ of Queensland, is issued as Botany Bulletin XV by the Queensland Department of Agriculture. The thirty-eight pages are accompanied by seventeen excellent plates from pen drawings.—J. C. A.

ITEMS OF TAXONOMIC interest are as follows: In the last fascicle of *Pittonia* (**3**: 329–344. 1898) Professor Greene continues his descriptions of new species of Convolvulus, nine of which are described; proposes four new species of Canadian violets, from Macoun collections; and describes a fascicle of new labiates, thirteen in number.—S. B. Parish has begun in *Erythea* (**6**: 85–92. 1898) a series of important papers on new or little known plants of southern California. The first one discusses about fifty plants, describing five new species and six new varieties.—J. M. C.

A NEW SPECIES of Pleodorina, *P. Illinoisensis*, is described by C. A. Kofoid in a recent Bulletin of the Illinois State Laboratory of Natural History, and illustrated with two plates showing form and development. Comparisons are made with *P. Californica*, now known from Indiana and Illinois as well as California. It is also pointed out that there are some reasons for thinking that the new form may be only a stage in the development of Eudorina, probably of *E. elegans*. We note an omission in the bibliography of the article by Severance Burrage on "A new station for Pleodorina Californica" in *Proc. Ind. Acad.* **1895**: 99–100.—J. C. A.

AT A RECENT meeting of the Imperial Academy of Sciences in Vienna, Dr. Wilhelm Figdor, assistant in the institute for plant physiology of the University of Vienna, read a paper entitled "Investigations upon the phenomena of sap pressure (Blutungsdruckes) in the tropics." A summary of his results is translated from the *Österreichische Botanische Zeitschrift* **48**: 359. 1898.

"1. In the tropics in contrast with the prevalent relations in our latitudes, there is always a positive sap pressure, which shows a very different intensity in the various plants observed.

"2. The amount of sap pressure attained in general is two or three times

as great as with us. The strongest pressure observed was somewhat more than eight atmospheres in *Schizolobium excelsum* Vog.

"3. The sap pressure varies, often very markedly, in one and the same plant within twenty-four hours. This phenomenon cannot be ascribed to daily periodicity alone, but must be referred to the influence of external factors, especially to the transpiration, which even in the tropics, is very copious."—C. R. B.

PROFESSOR WIESNER presented at the June meeting of the Imperial Academy of Sciences in Vienna a memoir entitled "Contributions to the knowledge of the photo-chemical climate in Arctic regions." His results (translated from *Österreichische Botanische Zeitschrift* **48**: 360. 1898) are as follows:

"1. In high northern regions (Advent bay, Tromsö) the chemical intensity of the total daylight, with equal elevation of the sun and equal cloudiness, is greater than in Vienna and Cairo, but less than in Buitenzorg, Java. At Trondhjem the same is true, but with a considerably greater approximation to the conditions at Vienna.

"2. With a completely overcast sky, the intensity of the light was observed to increase much more regularly with the height of the sun at Advent bay than in any other vegetation region observed.

"3. At Advent bay with equal elevation of the sun and equal cloudiness, the chemical intensity of light in the morning and afternoon were nearly equal; however, in most cases the afternoon intensity is somewhat greater than the morning.

"4. The greatest intensity of the total daylight and the diffuse light is to be observed in all regions upon a vertical surface, which faces the sun; the smallest upon the opposite vertical surface. The intensity upon the intermediate planes lies somewhere between that of the first two.

"5. Even with a completely clear sky, the distribution of the light intensity upon the illuminated vertical plane is not completely symmetrical.

"6. With increasing elevation of the sun, the direct light (*Vorderlicht, i. e.*, the average light falling upon the vertical plane) in comparison with the sky light (*Oberlicht, i. e.*, the total daylight measured upon a horizontal plane) diminishes. In Advent bay at the beginning of August, the ratio of the direct light to the skylight is as 1 : 1.5–2.2, whereas in Vienna in May this ratio may exceed 1 : 4.

"7. For days of equal elevation of the sun at midday the daylight totals in Arctic regions are considerably greater than in temperate latitudes. At the beginning of August the average daylight total at Advent bay is about two and one-half times greater than on similar days in Vienna (at the beginning of November and February).

"8. The light climate of the high northern vegetation region is charac-

terized by a relatively greater uniformity of light intensity than is attained in any other vegetation region. This great uniformity expresses itself first in the low maxima and the high minima of the intensity of the total daylight, which again is dependent upon the course of the daily position of the sun, The daylight totals rise from spring to summer in the high Arctic regions much more slowly, and fall from summer to autumn much more slowly, than in temperate latitudes. Besides, the intensity of the direct light (*Vorderlicht*) in the north is nearer to that of the sky light (*Oberlicht*) than in other regions. The strength of the light, with complete cloudiness, increases with increasing elevation of the sun in no other region so uniformly as in the Arctic. Finally, the fact that the midnights of the north are most strongly, and those of the south most weakly, illuminated contributes to the uniformity of light intensity.

"9. The observations made at Advent bay establish the point already made by the author, that the share of the total light which plants obtain is greater the smaller the intensity of the total light is; of course, except in those regions in which the rays of the sun actually retard the development of plants (steppes and deserts). The greatest amount of the total light is received by plants of the Arctic regions. Their great need of the existing light excludes any self-shading of plants (*i. e.*, by their own leaves) in extreme northern regions, and in the neighboring southern regions (*e. g.*, in Hammerfest) only a minimal (physiological) branching of woody plants is possible."

A later memoir will concern itself with the connection of the climate thus described with the character of the vegetation.—C. R. B.

Mr. U. Susuki, after a short exposition of his experiments in the *Botanisches Centralblatt* **75** : 289. 1898, avers that "these results leave no longer any doubt that nitrates can be assimilated and proteids formed in darkness." Dr. O. Loew adds that this confirms what he had long ago deduced from analogy in the culture of molds. Mr. Susuki's full paper will be published in the bulletin of the Agricultural College of Tokyo.—C. R. B.

In general style, Mr. F. N. Williams' recently issued *Revision of the genus Arenaria*[9] is not unlike his synoptic treatment of Silene, already noticed in these pages. Arenaria, however, is from its nature capable of more satisfactory division into subgenera and sections than Silene, and Mr. Williams seems also to have made a somewhat more detailed statement of the minor varieties and forms than in his earlier paper. He limits the genus Arenaria to the species which have estrophiolate seeds and divided or bidentate capsule-valves, thereby excluding Alsine, Mœhringia, Honkenya, etc. But, even as thus restricted, Arenaria includes the following reduced genera: *Alsinella* S. F. Gray, *Bigelowia* Raf., *Brachystemma* Don, *Brewerina* A.

[9] Journal of Linnean Society **33**: 326–437. 1898.

Gray, *Dolophragina* Fenzl, *Dufourea* Gren., *Eremogone* Fenzl, *Euthalia* Rupr., *Gouffia* Robill. & Cast., *Leptophyllum* Ehrh., *Lepyrodiclis* Fenzl, *Odontostemma* Benth., *Pettera* and *Plinthine* Reichb.,—a list sufficiently formidable to show the widely divergent views which have been held as to the generic limitations of the group.

Mr. Williams recognizes seven subgenera of which the salient characters may be summarized thus:

Euarenaria. Glands of disk obsolete; capsule-teeth 6.

Eremogoneastrum. Glands prominent; capsule dehiscent to below the middle by six valves; mostly cespitose perennials.

Pentadenaria. Glands 5; capsule 6-toothed; perennials, often suffruticose.

Dicranilla. Glands present; capsule dehiscent beyond the middle by six valves; flowers solitary, terminal, minute; S. American tufted alpine species.

Arenariastrum. Capsule dehiscent by 4 teeth; glands inconspicuous.

Odontostemma. Capsule dehiscent by 4 valves; filaments bidentate near the base.

Macrogyne. Capsule dehiscent by 4 valves; styles much exserted.

All but the last subgenus are again divided into two to five tolerably well marked sections. Our interest naturally centers upon the treatment of the North American species. Of these Mr. Williams recognizes fourteen, which he arranges thus:

Subg. EUARENARIA.

§ *Euthaliana* (with seeds granulate-tuberculate).

A. Benthamii.

A. serpyllifolia.

§ *Leiosperma* (with smooth globose, reniform, or lenticular seeds).

A. lanuginosa.

A. saxosa.

§ *Eremogoneæ* (with smooth, compressed, pyriform or oblong seeds).

A. congesta.

A. Franklinii.

A. Hookeri.

A. compacta.

A. aculeata.

Subg. PENTADENARIA.

A. ursina.

A. capillaris.

A. macradenia.

A. Fendleri.

A. ciliata.

This subdivision is certainly natural and theoretically clear. It is to be feared, however, that the gland distinction between Pentadenaria and Euare-

naria § Eremogoneæ will prove difficult, if not impossible, in practice. It will be noted that in the number and limitation of our North American species, Mr. Williams suggests scarcely any change. Of *A. Benthamii* he proposes a var. *diffusa*, based upon Mr. Heller's no. 1686 from Kerr county, Texas. Concerning *A. serpyllifolia* he says, "introduced into North America, but scarcely naturalized there;" but certainly no introduced caryophyllaceous plant except the cerastiums has taken more kindly to American soil, for it is frequent from Maine to the Pacific coast and may often be found in places quite remote from dwellings. In the subdivision of this species, var. *tenuior* Koch does not appear even in the synonymy. On page 412, *A. ursina* is again separated from *A. capillaris*, on the ground that "none of the many forms of *A. capillaris* have glaucous leaves and emarginate petals." But the emarginate character of the petals is not a strong one and on a succeeding page Mr. Williams himself says, "As Ledebour points out, typical *A. capillaris*, which is widely distributed in Siberia, is a glabrous plant with short barren shoots and rigid glaucous leaves."

From Mexico Mr. Williams recognizes nine species and six varieties, his *A. megalantha* (*A. lanuginosa* var. *megalantha* Rohrb., *A. alsinoides* var. *ovalifolia* J. D. Smith) being new in conception.

In a prefatory note it is stated that in the spelling of geographic names the "Times" atlas has been followed. We are unacquainted with this work but should not place implicit confidence in it if "Chinautla" and "Sempaaltepec" are samples of its orthography.

Once more it must be said that Mr. Williams could add greatly to the value of his papers through citing by numbers a few authentic specimens under each species and variety. However, the treatment of Arenaria shows on the whole even more to praise and less to criticise than that of Silene. —B. L. ROBINSON.

A RECENT work of Cavara[10] deals largely with the finer structure of the nucleolus. *Ornithogalum umbellatum, Cucurbita maxima, Crinum giganteum, Narcissus poeticus, Lilium Martagon*, and others, furnished material. Absolute alcohol, alcoholic corrosive sublimate, Carnoy's fluid and Merkel's fluid were the principal fixing agents. Zimmerman's iodine-green and fuchsin was recommended for staining on account of its rapid and effective work, but many other stains were used including the methyl-green-eosin-orange of Erlich, and Flemming's safranin-gentian-violet-orange. Celloidin was used for embedding.

He believes that nucleoli are not thrust out but are taken up by the nuclear thread. A series of figures, apparently somewhat diagrammatic, represents the nucleoli in great detail, but the nuclear thread does not receive equal

[10] CAVARA, F.— Intorno ad alcune strutture nucleari. Atti dell' Istituto botanico della R. Università di Pavia II. **5**: 1–49. *pl. 2.* 1898.

attention. During mitosis the structure of the nucleolus is lost, its staining power is lessened and it breaks up into small pieces which show no staining capacity. These pieces are taken up by the nuclear thread and are to be regarded as condensation bodies of nutritive material. They may form plastin for spindles or chromatin for chromosomes. He says that this view resembles that of Hertwig, Flemming, and others. If it should be correct, it argues against the individuality of chromosomes.—C. J. CHAMBERLAIN.

IN THE WINTER of 1895–6, Börgesen and Paulsen carried on some important ecological studies in the West Indies. The results of their investigations have been published only recently.[11] The work is divided into two main parts: I. The halophytic vegetation, by Börgesen; II. The forests and thickets, by Paulsen. In addition there is an appendix containing a statement of the new spermatophytes, and a list of the algæ and fungi observed. The book is fully illustrated with eleven full-page plates from Börgesen's photographs, and many text figures.

The halophytic vegetation is treated of under five heads: 1. *The sea weeds.* Of chief importance are the Halimeda and Caulerpa forms, growing so densely as to form a solid mass. Some extraordinary Caulerpas are described, one closely resembling *Carex arenaria* in its external form. Its creeping, sharp-cornered stem sends out assimilation shoots and rootlets.

2. *The vegetation of the sandy beaches.* These beaches are composed principally of coral fragments, lime, and particles of limy algæ. On account of the weight of these sand grains no dunes are formed, even by the strongest winds. All the plants are protected in various ways against loss of water. The blades of grass are rolled up, and on other plants the leaves are bluish-gray and often very fleshy. Their elliptical or spatulate forms also give a small proportion of leaf exposure. The runners are above ground, as there is no danger of harm by flying sand. The Canavalia has dorsiventral leaves, the epidermis is provided with glandular, bristly hairs, some of the cells are arranged as stomata but do not function as such, and become crystal bearing. The Cocoloba has brilliant, upward turned leaves, the upper epidermis is strongly cuticularized, without stomata, and is impregnated with tannic acid. Many other forms are described, some having water cells, oil glands, cells containing calcium oxalate crystals, etc.

3. *The vegetation of the rocky coasts*, consisting of characteristic agaves, cacti, bromelias, and croton forms.

4. *The mangrove vegetation*, surrounding and encroaching upon all the bays, brackish lakes, and salt ponds, wherever there is found protected water. One of the most prominent forms is the Rhizophora, which has two kinds of aerial roots. Some spring from the principal stem standing at right angles

[11] The vegetation of the Danish West Indies. Copenhagen. 1898. *Cf.* Bot. Centralbl. **74**: 143. 1898.

and later turning downwards. The others grow from the branches of the tree perpendicularly downwards, branching at the surface of the water where the tips die and decay. The structure of these aerial roots is fully described.

5. *The vegetation of the salt clay plains.* These stretches surround the lagoons and salt ponds and upon them is an overflow of some of the forms described above. In drier localities live some herbaceous forms and some of those growing erect on the beaches are here recumbent.

Under the forest and thicket vegetation each island is discussed separately. The Hurricane island, which forms the western boundary of the harbor of St. Thomas, is sparsely inhabited and mostly covered with a xerophytic vegetation, whose density is increased by thorn growths and lianas. The trees are generally smooth leaved, the shrubs hairy leaved, and the most important succulents are the agaves, bromelias, and some opuntias.

In the interior of the island of St. Thomas grow many croton bushes, as well as forests of larger trees, a long list of which is given. Epiphytic orchids, arums and ferns also abound, *Cuscuta Americana* being especially widespread. St. John is very fertile, though little cultivated on account of the indolence of the natives.

Lately some promising experiments with the cultivation of coffee and cocoa have been undertaken. The croton underbrush has been pretty well crowded out of this island, and there are great grassy stretches near the deeper forests. St. Croix is the most important of the Danish Antilles, and is the chief seat of the Danish cane-sugar industry. In the uncultivated portions the vegetation is similar to that of the other islands. Upon the fallow fields the weeds are always woody. The gray crotons cover most of the eastern half of the island, and are more xerophytic and smaller than elsewhere. Only a few trees are found, and lianas are scarce, but the succulents richly supply their place. The chief characteristic of the vegetation is its xerophytic adaptation. With the exception of the legumes, the leaves are entire, stiffy haired, usually ovate and short stemmed. Thorns of every sort abound. In the valleys we find the luxuriant vegetation of the tropics, oranges, figs, etc. Upon the trees was seen the Tillandsia, and in damp places Psilotum and *Pilea macrophylla*.

In the last division of the second part the author treats of the anatomy of the xerophytic foliage leaves, having investigated three groups: (1) the decidedly hairy leaves; (2) the slightly hairy and smooth leaves; (3) two types of leguminous leaves. He thinks the structure of the smooth leaves not anatomically different from that of the hairy leaves, but the outer epidermal walls are very much thicker. This is also true of the leguminous leaves. The abundant glandular hairs are depressed on the smooth leaves, and stand among the other hairs on the hairy leaves. They closely resemble the hydathodes described by Haberlandt. The leaf anatomy of *Evolvulus nummularis* and of *Loranthus emarginatus* is fully described.—S. M. COULTER.

NEWS.

PROFESSOR L. H. BAILEY has returned from Europe before completing his proposed year abroad.

THE PENN PUBLISHING COMPANY announces a booklet by Mrs. Julia McNair Wright to be called *The story of plant life.*

MR. E. O. WOOTON has been appointed professor of botany at the New Mexico Agricultural College and Experiment Station.

FROM *Erythea* we learn that Dr. Marshall A. Howe has nearly completed an illustrated monograph of Californian Hepaticæ.

HENRY HOLT & CO. announce for publication this fall an elementary botany by Professor George F. Atkinson, of Cornell University.

PROFESSOR STANLEY COULTER, of Purdue University, who spent most of the time of his vacation trip in the botanical laboratory at Bonn, has returned to his home.

DR. CHARLES R. BARNES was elected vice president, and chairman of section G (botany), A. A. A. S., for the fifty-first meeting, which is to be held at Columbus, Ohio.

PROFESSOR A. F. W. SCHIMPER, of the University of Bonn, has been called to Basel as the successor of Professor Dr. George Klebs, who goes to the University of Halle.

MR. F. O. GROVER, of Harvard University, has been appointed instructor in botany in Oberlin College to succeed Professor H. L. Jones, whose untimely death we chronicled last month.

THE ENGLISH TRANSLATION of Dr. Franz Lafar's *Technical mycology*, already published in England, is announced for fall publication by the Lippincott Company, of Philadelphia.

DR. O. BREFELD, director of the Botanical Garden and Institute at Münster, has been unanimously called to the University of Breslau, to succeed the late Dr. Ferdinand Cohn.

DR. O. LOEW, of Munich, has accepted a call to the Department of Agriculture at Washington. He brings to the department his thorough knowledge and high reputation as a chemist devoted to the problems of plant physiology. The department is to be congratulated upon procuring the

services of a man whose contributions to chemical physiology are so widely and favorably known.

MRS. WILLIAM STARR DANA is shortly to add another work to the series of which she is author. This one is to be entitled *How to know ferns.* It will be published by Charles Scribner's Sons.

THE UNIVERSITY OF ABERDEEN has received a legacy of £15,000 for founding the Cruickshank Botanical Garden. The director of the garden will be James W. Traill, professor of botany in the university.

MR. W. T. SWINGLE, who has been spending the year abroad, part of the time in the laboratory of Professor Pfeffer at Leipzig, will remain away several months longer before resuming his duties in the U. S. Department of Agriculture.

MR. M. A. CARLETON is now in Russia as an agent of the U. S. Department of Agriculture to study the cereals of that region. The results of his extended investigations upon the rusts of cereals were sent to press before his departure, and will be issued as a Bulletin of the Division of Vegetable Physiology and Pathology.

THE LLOYD MYCOLOGICAL MUSEUM was increased during 1897 by nearly a thousand named specimens, and a list of the species and donors is given in the third report of the museum just issued. Fleshy fungi, both dry and preserved in alcohol, are desired. Correspondence should be addressed to Mr. C. G. Lloyd, Cincinnati, Ohio.

DR. DANIEL MORRIS, assistant director of the Kew Botanical Gardens, has resigned this post to accept a government appointment as Imperial Commissioner of Agriculture for the British West Indies, having in charge the newly established "Botanical Department." We are not informed what the relations of the commissioner to the present garden directors is to be. *Natural Science* suggests that he "will not be welcomed with open arms by the many botanists in those parts, which already have an excellent botanical garden and staff in Jamaica." Dr. Morris sailed from England September 21st, for Barbadoes, where he will establish his headquarters.

THE BOTANICAL SOCIETY OF AMERICA elected the following officers for the coming year: *President,* Lucien M. Underwood, of New York; *Vice President,* Benjamin L. Robinson, of Cambridge; *Secretary,* George F. Atkinson, of Ithaca; *Treasurer,* C. Arthur Hollick, of New York; *Councillors,* Charles E. Bessey, of Lincoln, and Wm. P. Wilson, of Philadelphia. The following were elected members of the society: Robert A. Harper, University of Wisconsin, Madison; Edward A. Burt, Middlebury College, Middlebury, Vt.; Herbert J. Webber, Department of Agriculture, Washington, D. C.; L. H. Pammel, Iowa Agricultural College, Ames; Albert S. Hitch-

cock, Kansas Agricultural College, Manhattan; Herbert Maule Richards, Harvard University, Cambridge, Mass.; David G. Fairchild, Department of Agriculture, Washington, D. C.; David M. Mottier, University of Indiana, Bloomington.

THE MACMILLAN CO. announce for early publication two books by Professor L. H. Bailey, of Cornell University, one a *Text-book of Agriculture for Schools*, and the other a volume entitled *The Evolution of our Native Fruits*. Among their other volumes announced for the autumn is the one upon the *Evolution of Plants* by Dr. Douglas H. Campbell, of Leland Stanford University, and a new volume of the Rural Science series on the *Physiology of Plants* by Dr. J. C. Arthur, of Purdue University. Welcome information to physiologists, also, is the statement that a translation of Verworn's *Allgemeine Physiologie* is in preparation by Dr. F. S. Lee, adjunct professor of physiology in Columbia University.

THE STATE OF HAMBURG has just established at Freihafen a station for plant protection. Dr. C. Brick has been transferred from the Botanical Museum of Hamburg to the direction of this station, and Dr. L. Reh has been appointed zoologist. Occasion for the establishment of the station was afforded by necessary investigation of American fruits imported into Hamburg in order to protect orchards against the San José scale. Besides this, the station will look after the introduction of injurious insects with the shipments of living plants from abroad. Its duties will include, also, the combating of plant diseases, the oversight of the schools of viticulture, and the inspection of vineyards and orchards in the Hamburg region, together with such questions as arise in the prosecution of this work.

THE FIFTH annual meeting of the Botanical Society of America was held in the Rogers Building of the Massachusetts Institute of Technology, Boston, August 19–20, 1898. The sessions of the society on the 19th were devoted to business matters. The literary sessions on the 20th were presided over by president N. L. Britton. The address of the retiring president, John M. Coulter, in his absence, was read by Dr. B. M. Davis, and is published in full in this issue. The following papers were read before the society: Reducing division of the chromosomes in *Arisæma triphyllum*, by ring and tetrad formation during sporogenesis: *Geo. F. Atkinson.* Symbiotic saprophytism: *D. T. MacDougal.* Sporogenesis in *Trillium grandiflorum*: *Geo. F. Atkinson.* Forest distribution in New Jersey and its relation to geology: *Arthur Hollick.* The centrosphere in Corallina: *B. M. Davis.* Tetrad formation in *Tsuga Canadensis: W. A. Murrill;* presented by Geo. F. Atkinson. Notes on a Helianthus from Long Island: *N. L. Britton.* Preliminary note on fertilization in the white pine: *Miss M. C. Ferguson;* presented by invitation of the Council. A fossil moss from the state of Washington: *Mrs. E. G. Britton.*—G. F. A.